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The Engineer

PRINCIPAL CONTENTS OF THIS ISSUE.

PROGRESS OF THE ENGINEERING INDUSTRIES IN 1924:—
Locomotive Construction, Shipbuilding, Sanitation, Aeronautics, Naval Construction, Electrical Engineering.

THE BRITISH STEAM RAILWAY LOCOMOTIVE
From 1825 to 1924—No. I.

The Motor Liner Aorangi—No. I.

PUBLIC NOTICES

The Director - General, India Store Department, Branch No. 15, Belvedere-road, Lambeth, S.E. 1, REQUIRES—
BODY IRONWORK and FITTINGS for RAILWAY CARRIAGES.
Tenders due on the 23rd January, 1925.
Tender forms obtainable from above. 7932

Section Engineers (6) REQUIRED for the CONSTRUCTION BRANCH of the FEDERATED MALAY STATES RAILWAYS for four years' service, with possible extension. Salary 400 dollars a month, rising to 475 dollars a month by annual increments of 25 dollars a month plus a temporary non-pensionable allowance of 10 per cent., which is liable to cancellation or revision, plus a commuted field allowance of 50 dollars a month. The exchange value of the dollar in sterling is at present fixed by the Government at 2s. 4d., but its purchasing power in Malaya is at present considerably less than that of 2s. 4d. in the United Kingdom. Free passage provided. On expiration of agreement a bonus of six months' salary may be allowed, provided the work and conduct of the person engaged has been in every way satisfactory. Candidates, age 30 to 38 and unmarried, must be fully qualified railway engineers who have received good training and experience on recognised European, American or Colonial railways. Members or Associate Members of the Institution of Civil Engineers preferred.—Apply at once by letter, stating age, whether married or single, and particulars of qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, S.W. 1, quoting at top of application M/13,264. 7883

SECRETARY.

The Institution of Water Engineers DESIRE APPLICATIONS for the POST of SECRETARY. The gentleman appointed would be required to devote sufficient of his time for the duties of the position and also to provide suitable office accommodation in London for the administration work of the Institution.—Address, stating qualification, salary required, &c., 7902, The Engineer Office. 7902

Administrative County of LONDON. The London County Council REQUIRES a LECTURER at the L.C.C. Norwood Technical Institute, Knight's-hill, West Norwood, S.E. 27, to give a Course of Ten Popular Lectures on WIRELESS TELEPHONY on Friday evenings, commencing at an early date. Lecturing experience on scientific subjects essential. Fee 30s. a lecture.
Preference given to those who have served or attempted to serve with H.M. Forces. Apply, Education Officer (T.1 (a)), stamped addressed foolscap envelope necessary, for form, to be returned by 10th January, 1925. Canvassing disqualifies.
JAMES BIRD,
7927 Clerk of the London County Council.

Applications are Invited for the POST of LECTURER in MECHANICAL ENGINEERING, Government Technical Institute, Insein, Burma.
Three years' agreement. Salary Rs. 1000 per mensem. Free house. Provident Fund. Free passage to Burma and return passage at end of agreement.
QUALIFICATIONS.—Age preferably 30-40 years. Honours Degree in Engineering of a British University, experience in teaching and in engineering works. Good knowledge of internal combustion engines desirable.
Further particulars may be obtained from the SECRETARY to the HIGH COMMISSIONER for INDIA, 42, Grosvenor-gardens, London, S.W. 1. Last date for receipt of applications 31st January, 1925. 7897

Portsmouth Municipal College. MECHANICAL ENGINEERING AND BUILDING TRADES DEPARTMENT.
APPLICATIONS are INVITED for the POSITION of a WORKSHOP INSTRUCTOR at the above College. Applicants should be building trade craftsmen, preference being given to a candidate holding a Handicraft Certificate of the City and Guilds Institute.
Further particulars and forms of application may be obtained from the undersigned, to whom applications, accompanied by copies of not more than three recent testimonials, should be returned at once.
H. E. CURTIS,
Secretary.
Offices for Higher Education,
The Municipal College, Portsmouth. 7880

RESEARCH DEPARTMENT, WOOLWICH.

ONE SECOND-CLASS DESIGNER REQUIRED.

Candidates must possess highly technical and practical experience and some electrical knowledge. High-pressure vessels, scientific and experimental laboratory apparatus, and factory machines.

Age 30–45.

Scale of wages, commencing 75s. 3d. per week to 85s. 9d. per week, which, with Civil Service bonus, at present amounts to 115s. 6d.–128s. 10d. per week.

Annual leave 18 days.

Applications, in writing, with copies of testimonials and references, should be made to the CHIEF SUPERINTENDENT, Research Department, Woolwich, S.E. 18. 7895

The Queen's University of BELFAST. JUNIOR ASSISTANT IN ENGINEERING.
APPLICATIONS are INVITED for the POST of JUNIOR ASSISTANT in the Department of Civil Engineering. Salary £200 per annum, duties to commence early in January, 1925.
Further particulars may be obtained from the undersigned, by whom applications with testimonials must be received on or before Saturday, January 10th, 1925.
W. H. HUMMEL,
7884 Professor of Engineering.

PUBLIC NOTICES

City of Birmingham Water DEPARTMENT. BARTLEY RESERVOIR.
The Water Committee invite TENDERS for the CONSTRUCTION of the BARTLEY RESERVOIR on a site adjoining their existing Reservoir at Frankley, near Birmingham.
The reservoir will be a storage reservoir with a content of over 500 million gallons. The works will comprise the following:—
An earthen embankment with shallow cut-off trench and reinforced concrete core wall, valve tower with reinforced concrete footbridge, outlet culvert and pressure tunnel, inlet culvert and channel, inlet gauge chamber and recorder house, reservoir lining consisting of pre-cast concrete slabs, reinforced concrete in situ, pitching and beaching, road diversions and other subsidiary works.
Conditions of contract (which include the Corporation's usual fair wages and conditions of labour clauses), specifications and forms of Tender may be obtained on and after December 30th, 1924, from the Secretary, Water Department, Council House, Birmingham.
All applications for Tender forms must be accompanied by a deposit of £10, which will be returned to the applicant on receipt of a bona fide Tender.
The drawings may be seen at the Water Department Offices (Secretary's Office entrance), Council House, between the hours of 10 a.m. and 1 p.m. on December 30th, 1924, January 2nd, 6th, 9th, 13th, 16th, and 20th, 1925. An Assistant Engineer will be in attendance on these dates between 11 a.m. and 1 p.m. After 2 p.m. he will attend at the reservoir site to afford any further information to tenderers.
Tenderers desiring to have copies of any of the drawings, to assist them in preparing their Tenders, will be supplied with such copies upon payment to the Secretary of 2s. 6d. per copy, which amount will not be returned. All drawings so supplied must be returned to the Secretary under separate cover at the same time as the Tender is submitted.
Tenders must be delivered under seal, addressed to "The Secretary, Water Department, Council House, Birmingham," endorsed "Tender for Bartley Reservoir, Contract No. 12," not later than Noon on 26th January, 1925.
The Committee do not bind themselves to accept the lowest or any Tender.
J. H. BROADLEY,
Secretary.
Water Department, Council House,
Edmund-street, Birmingham,
19th December, 1924. 7830

Liverpool Corporation Electric SUPPLY DEPARTMENT. PLANT FOR SALE.
The Corporation of Liverpool invite OFFERS for the PURCHASE and REMOVAL of FIVE 200 K.W. MOTOR GENERATORS, now lying at the Pumpfields Station, Vauxhall-road, Liverpool.
Each motor generator consists of an A.C., 6900-volt, 3-phase, 50-period, squirrel-cage motor and a D.C., 470/525-volt generator.
The full-load speed of the machines is 429 r.p.m. and output 400 amperes at 500 volts. The machines are in thorough working order and have been removed to make room for larger plant.
The machines may be inspected by arrangement with the City Electrical Engineer, 24, Hatton-garden, Liverpool, from whom further particulars may be obtained.
Offers should be delivered to the City Electrical Engineer not later than 16th January, 1925, and endorsed "Offer for Electric Plant."
The Corporation do not bind themselves to accept the highest or any Offer.
WALTER MOON,
7904 Town Clerk.

WANTED,
ONE COPY, "THE ENGINEER," DATED DECEMBER 16th, 1910, COMPLETE WITH SUPPLEMENTS.
State price to P1000, The Engineer Office. P1000

PUBLIC NOTICES

Metropolitan Borough of HAMMERSMITH. ELECTRICITY DEPARTMENT.
The undermentioned superseded PLANT installed at Hammersmith Electricity Works is offered FOR SALE:—
THREE Davey-Paxman "Economic" Type BOILERS, with SUPERHEATERS, including 4 STEEL STORAGE VESSELS, ECONOMISERS, PUMPS, PIPING, &c.
Specification and full particulars from the Deputy Engineer and Manager, Electricity Department, 85, Fulham Palace-road, London, W. 6.
The dismantling and removal of the plant to be carried out by the purchaser at his own expense and risk.
Offers must be submitted to the Town Clerk, Town Hall, Hammersmith, W. 6, properly endorsed, not later than 4 p.m. on Friday, 16th January, 1925.
HUGH ROYLE,
Town Clerk.
Town Hall, Hammersmith, W. 6,
22nd December, 1924. 7887

Urban District Council of FLEET (HANTS).
EXTENSION OF EXISTING SEWERAGE AND SEWAGE DISPOSAL WORKS FOR FLEET.
UNEMPLOYMENT RELIEF WORKS.
GENERAL CONTRACT.
DATE FOR RECEIPT OF TENDERS EXTENDED TO 21st January, 1925.
The Urban District Council of Fleet invite TENDERS from responsible and experienced contractors for the CONSTRUCTION of these WORKS which comprise several miles of Cast Iron and Stoneware Sewers, Brick, Concrete and Cast Iron Manholes, Flushing Tanks, Ventilating Shafts and Columns, Cast Iron Rising Main, Air Main, and additions to the Sewage Disposal Works, and other incidental work.
A copy of the specification and form of Tender, and bills of quantities may be obtained, and the drawings inspected, on and after the 3rd January, 1925, on application, in writing, to Major T. J. Moss-Flower, Chartered Civil Engineer, 28, Victoria-street, Westminster, S.W., and Carlton Chambers, Bristol, at his Bristol office, on deposit of a £10 Bank of England Note, which will be refunded provided a bona fide Tender be received, and is not withdrawn before the sealing by the Council of one of the Tenders, and provided also that all documents supplied be returned to the Engineer. On production of a receipt for the deposit, persons tendering may inspect the plans at Fleet on a day and at a time and place which will be communicated to them.
The Contractor carrying out the work will be required to comply with the regulations of the Unemployment Grants Committee with regard to the employment of labour during the performance of the contract.
Sealed Tenders, endorsed "Tender for Fleet Sewerage and Sewage Disposal Works, General Contract," are to be delivered at the Council Offices, not later than Noon on the 21st January, 1925.
The lowest or any Tender will not necessarily be accepted.
Dated this 15th day of December, 1924.
ERNEST NASH,
Clerk to the Council.
Council Offices,
Fleet (Hants). 7900

Sudan Government Railways REQUIRE the SERVICES of a DISTRICT ENGINEER. Age 26 to 32, preferably single. Should have good knowledge of survey and permanent way work and possess A.M.I.C.E. or equivalent. Preferably trained on British railway. Starting rate of pay £E480 to £E540, according to age and qualifications. Free first-class passage out and home. Progressive post if retained. Strict medical examination.—Apply by letter to CONSULTING MECH. ENGINEER, Sudan Government Railways and Steamers, Wellington House, Buckingham-gate, S.W. 1. 7885

PUBLIC NOTICES

Bombay, Baroda, and Central INDIA RAILWAY COMPANY.
The Directors are prepared to receive up to Noon on Wednesday, 14th January, TENDERS for SUPPLY of:—
WHEEL CENTRES AND AXLES FOR CARRIAGES AND WAGONS.
Tenders must be made on forms, copies of which, with specification, can be obtained at these offices on payment of 10s. each (which will not be returned). The Directors do not bind themselves to accept the lowest or any Tender.
S. G. S. YOUNG,
Secretary.
Offices: 91, Petty France,
Westminster, S.W. 1,
29th December, 1924. 7903

County Council of the County OF INVERNESS.
INVERNESS-PERTH ROAD.
CONSTRUCTION, RECONSTRUCTION, AND SURFACING.
CONTRACT NO. 1.
From INVERNESS to the BOUNDARY between the FIRST and THIRD DISTRICTS, a length of approximately 8½ miles.
EARTHWORK, BOTTOMING, SURFACING, KERBING, DRAINAGE, AND FENCING.
The Council are prepared to receive TENDERS for the CONSTRUCTION of the above Section of the INVERNESS-PERTH ROAD, being the first portion of a total length of 80 miles.
Drawings and specifications, &c., may be seen on and after 1st January, 1925, at the offices of:—
The Chief Engineer, 98-102, Academy-street, Inverness;
The Ministry of Transport, 4, Drumsheugh-gardens, Edinburgh;
The Ministry of Transport (Roads), 7, Whitehall gardens, London, S.W. 1.
Specification, bill of quantities, form of Tender, and all further information required may be obtained on and after the same date at the office of the Chief Engineer, Major Robert Bruce, 98-102, Academy-street, Inverness, on depositing £3 3s., which deposit will only be returned on receipt of a bona fide Tender and the return of all the documents. Cheques should be made payable to the County Council of the County of Inverness.
Contractors may, if they so desire, submit separate Tenders for:—
(a) All the work other than surfacing work;
(b) Surfacing work.
A conveyance will be provided, and an Engineer will meet contractors at Inverness Railway Station at 10 a.m. on Tuesday, the 6th January, 1925, to show them over the route.
Sealed Tenders, endorsed "Tender, Inverness Perth Road, Contract No. 1," must be lodged with the undersigned not later than Saturday, the 17th January, 1925.
The Council do not bind themselves to accept the lowest or any Tender.
J. W. McKILLOP,
County Clerk.
The Castle, Inverness,
27th December, 1924. 7890

The Great Indian Peninsula RAILWAY COMPANY, 48, Copthall-avenue, London, E.C. 2, invite TENDERS for—
1. IRONWORK for VESTIBULES of CORRIDOR CARRIAGES .... Fee 5s.
Tenders are due by 11 a.m. on 13th January, 1925. Tender forms obtainable at above address. Fees not returnable. 7929

South Staffordshire Waterworks COMPANY. CIVIL ENGINEERING DEPARTMENT.
APPLICATIONS are INVITED for the APPOINTMENT of SECOND CIVIL ENGINEERING ASSISTANT. Age 26-35 years.
Candidates must have had considerable experience in the design and maintenance of important water works, including impounding reservoirs, large pumping units, reinforced concrete service reservoirs, detection of waste and the distribution of water throughout large areas of supply.
Applicants must be corporate members of the Institution of Civil Engineers, having had responsible experience with a water company or Water Department of a Public Authority.
Ex-Service men will receive preferential consideration.
Commencing salary £450 per annum, which is subject to deductions under the Company's Superannuation Scheme.
Applications, stating age, details of education, training, qualifications, and particulars of experience, accompanied by copies (only) of three recent testimonials, endorsed "Civil Engineering Assistant," must be addressed and delivered to the undersigned not later than the 19th January, 1925.
FRED. J. DIXON, M. Inst. C.E.,
Engineer-in-Chief.
Engineer's Office,
26A, Paradise-street, Birmingham. 7888

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SITUATIONS OPEN

WANTED for Group of Collieries in South Wales, a fully qualified first-class SUPERINTENDING MECHANICAL ENGINEER. Must have had good experience of Colliery Work and a knowledge of Electricity as applied to Mining, &c. Only first-class energetic men need apply. State age, salary required, and give particulars of career and references.—Address, 7893, The Engineer Office. 7893 A

ENGINEER for the INSPECTION of STEEL, &c., on the Continent. Would reside in France or Belgium. Knowledge of French desirable.—Address, giving age and full particulars, salary, &c., 7846, The Engineer Office. 7846 A

ESTIMATOR REQUIRED. Capable of Making Estimates from Project Drawings for Mechanical Handling Plants for Coal and other materials; only men with good experience and proved abilities need apply. State age, experience and salary.—Address, 7840, The Engineer Office. 7840 A

EXPERT DESIGNER WANTED by Firm Specialising in Centrifugal and Turbine Pumps. Only widely experienced men need apply. State nationality, experience, age, and salary required.—Address, "PUMPS," Wm. Porteous and Co., Glasgow. P9935 A

PATENT AGENTS' ASSISTANTS, Male or Female, REQUIRED for Westminster, with experience in searching.—Address, with particulars of experience, education, age, and salary required, P9936, The Engineer Office. P9936 A

RATE FIXER for Engineering Works in East Anglia, Small Repetition Work; previous experience essential. State age, married or single, and salary required.—Address, 7931, The Engineer Office. 7931 A

REQUIRED for Service in India, an ASSISTANT to a DOCKYARD MANAGER, with a sound training in the design and construction of Hull and Machinery of Shallow-Draught Steamers. Preference will be given to an applicant with experience in estimating and supervising repairs of light river craft. Age not exceeding 35 and sound physique; state if married or single. Three years' agreement. Salary Rs. 700 to Rs. 800 per month; free quarters provided.—Apply to "Z. K. B.," c/o Deacon's Advt. Agency, Leadenhall-street, London, E.C. 3. 7937 A

THE NATIONAL OMNIBUS and TRANSPORT COMPANY, Limited, REQUIRE an ASSISTANT WORKS MANAGER, age about 30/35; Manufacturing Experience and good knowledge of Bodywork, Running Repairs and Maintenance of Rolling Stock essential.—Applications, giving full particulars of experience and salary required, to be addressed to THE SECRETARY, 206, Brompton-road, S.W. 3. Envelopes to be marked "AWM." 7770 A

TRAVELLER WANTED for London and District by a firm of engineers in the North. Must have a good connection amongst consulting engineers and architects. To a suitable man a high salary and bonus will be paid. Replies in confidence should state age, experience, and references.—Address, "PLANET," Wm. Porteous and Co., Advertising Agents, Glasgow. P9958 A

FIRM of ENGINEERS and IRONFOUNDERS in Lancashire REQUIRE the SERVICES of a REPRESENTATIVE for Lancashire and Yorkshire; must have good connection with Architects and Building Trade generally. State experience. Salary and commission basis.—Address, P9932, The Engineer Office. P9932 A

WANTED, DRAUGHTSMAN, for Works, Manchester district. Must be capable of designing Cotton Baling Presses. State age, experience, and salary required.—Address, 7891, The Engineer Office. 7891 A

WANTED, Experienced DETAILING DRAUGHTSMAN for Steel-frame Buildings.—State age, experience, and salary required to THE LONDON AND WALES STEEL CONSTRUCTION CO., 44, Bedford-row, W.C. 1, by letter only. 7913 A

WANTED, Experienced DRAUGHTSMAN, well versed in detail work in connection with the manufacture of Commercial Vehicles, for a firm in Lancashire.—Address, giving full particulars of experience, age, salary required, &c., 7886, The Engineer Office. 7886 A

WANTED, First-rate DRAUGHTSMAN, with Experience in designing Steel Bridges and Constructional Work.—Apply by letter only, stating age, experience, and salary required, to CHIEF DRAUGHTSMAN, John Butler and Co., Ltd., Stanningley Ironworks, near Leeds. 7899 A

WANTED for Commercial Vehicle Works in Lancashire, first-class DRAUGHTSMAN, with experience in Body Design and Detail Work in connection with 'Buses and other Passenger-carrying Vehicles.—Address, giving full particulars of experience, enclosing copies of references and state age and wages required, 7914, The Engineer Office. 7914 A

DESIGNING DRAUGHTSMAN REQUIRED in connection with Coal and Mechanical Handling Plants; only men with complete knowledge and first class experience need apply. State age, experience and salary required.—Address, 7841, The Engineer Office. 7841 A

DRAUGHTSMEN.—BEFORE NEGOTIATING with Government Departments in connection with any post, PLEASE COMMUNICATE with the GENERAL SECRETARY, Association of Engineering and Shipbuilding Draughtsmen, 96, St. George's-square, London, S.W. 1. 7817 A

REQUIRED for Important ARGENTINE RAILWAY:—2 GENERAL RAILWAY DRAUGHTSMEN, capable of designing Station Lay-outs, Track Work, &c.;
1 DRAUGHTSMAN, with experience of Steel Work Design;
1 ARCHITECTURAL DRAUGHTSMAN.
Three-year contracts at £400, £450, and £500 p.a. for 1st, 2nd, and 3rd years respectively, with free passage out and home.—Write, stating age and giving full particulars of education, training, and experience, with copies (only) of testimonials, to Box G.B.A., c/o Davies and Co., 95, Bishopsgate, E.C. 2. 7884 A

SITUATIONS OPEN (continued)

DRAUGHTSMEN REQUIRED for Aero-engine Work. Experience on high-class Petrol Engines essential.—State age, detailed particulars of experience, and salary required, to P.O., Box No. 77, Bristol. 7916 A

JUNIOR DRAUGHTSMAN WANTED for Consulting Engineer's Office; 30s. to 35s. per week. Only those willing to be useful in the drawing-office need apply. State age and qualifications.—Address, P9954, The Engineer Office. P9954 A

MECHANICAL DRAUGHTSMAN, First-class, WANTED, with extended experience in the Design of all classes of Material-handling Plant and Belt Conveyors.—Write, stating age, experience and salary expected, to FRASER and CHALMERS ENGINEERING WORKS, Erith, Kent. 7924 A

REQUIRED, First-class DRAUGHTSMAN, Thoroughly experienced in the design of Centrifugal Machines and Hydro-extractors. State age, salary required, and previous experience. All replies treated in strictest confidence. A competent man will be liberally dealt with.—Address, 7907, The Engineer Office. 7907 A

STRUCTURAL DRAUGHTSMAN WANTED in London District, having a knowledge of Preparing Shop Details for Steelframe Buildings. State age, previous experience and salary expected.—Address, 7928, The Engineer Office. 7928 A

WANTED by a Railway Wagon Building and Repairing Company, a capable SMITHY FOREMAN, experienced in Wood and Steel-frame Wagons; must be accustomed to R.C.H. drawings and specifications and used to estimating, piecework prices, &c. Wages £5 per week plus bonus (£30 last year) and family house.—Address, 7912, The Engineer Office. 7912 A

WANTED for East Coast Machine and Erecting Shop, FOREMAN over about fifty men; experience medium-size marine engines essential.—Address, P9938, The Engineer Office. P9938 A

SITUATIONS WANTED

WANTED, POST as ASSISTANT to Foundry Manager or Waterworks Engineer or Electrical Engineer, by young man, A.M.I.C.E., A.M.I. Mech. E (Chartered Civil Engineer), with thorough knowledge of foundry work and general engineering, also expert in C.I. pipes; will accept £6 10s. per week or nearest for FUTURE prospects. Age 34 years.—Address, 7934, The Engineer Office. 7934 B

A.M.I.C.E. (34), Works and D.O. Experience, locomotive, mechanical, steam and I.C.E., used to control of large staffs and maintenance work, economy specialist, DESIRES POST. Moderate salary.—Address, P9952, The Engineer Office. P9952 B

BUYER of ENGINEERING SUPPLIES, Who Has specialised in this sphere of work and has a very wide knowledge of the markets of the country for RAW MATERIALS, FINISHED ARTICLES, and General Engineering Supplies, is DESIRING NEW APPOINTMENT. Advertiser is a keen buyer, has had invaluable administrative and organising experience, is accustomed to controlling a large organisation.—Address, P9947, The Engineer Office. P9947 B

ENGINEER (35), A.M. Inst. C.E., SEEKS POSITION of permanent character in good firm. Experience in managerial duties, accountancy, D.O., marine, steam, motor, and semi-Diesel machinery, tank work, light structural steel, general engineering practice and the design and construction of small steel craft. Knowledge of French; available in May.—Address, P9951, The Engineer Office. P9951 B

ENGINEER or Works Manager. Thoroughly experienced blast-furnace and foundry management, equipment, and maintenance, costing, estimating; sound business common sense, practical, technical, good education and address.—Address, P9955, The Engineer Office. P9955 B

ENGINEER, Practical, Technical, Commercial, good organiser, (47), 30 years' experience home and abroad, OPEN to ACCEPT POSITION as Export Manager, home; alternatively, Manager or Representative, abroad.—Address, P9917, The Engineer Office. P9917 B

ENGINEER (34), Practical, Technical and Commercial training, experienced lay-outs complete factory plants and general mech. eng., SEEKS POST, D.O., buying, or erection.—Address, P9939, The Engineer Office. P9939 B

ENGINEER (30) SEEKS Good Permanent SITUATION on maintenance in small factory, laundry, &c.; 15 years' experience trade and marine. Sound knowledge of gas and steam engines, boilers, electric power and light. Good refs.—X., 44, Cranfield-road, London, S.E. 4. P9941 B

MECH. ENG. (23) DESIRES Any POST Where experience may be gained.—POTTER, 25, Jevington-gardens, Eastbourne. P9950 B

MECHANICAL ENGINEER (47), All-round Expert, designer, draughtsman, just returned from four years in Singapore, control of works of 200 hands, SEEKS POSITION, home or abroad; latest practice light and heavy steel work, works plant, rubber machinery, &c.—Address, P9957, The Engineer Office. P9957 B

RESIDENT ENGINEER or CONTRACTORS' AGENT, POSITION WANTED as; roads, bridges, docks, railways.—Address, P9934, The Engineer Office. P9934 B

YOUNG ENGINEER (24) SEEKS POST; 5 Years' sound experience as reinforced concrete designer, 16 months engineer in charge extensive construction work; thorough knowledge design and construction of piling and marine work. Used to responsibility and handling men. Office or outside work.—185, Felsham-road, Putney. P9953 B

SITUATIONS WANTED (continued)

SALESMAN (Home or Abroad), General Engineering machinery, machine tools, engineers' sundries; Birmingham man, age 43; last 14 years in Australia.—FRANK A. COOPER, 12, Beech-lanes, Birmingham. P9949 B

DRAUGHTSMAN and ENGINEER, London, All-round experience, 10 years shops, 14 years office; could take charge; moderate salary; or private work undertaken.—Address, P9945, The Engineer Office. P9945 B

ENGINEER DRAUGHTSMAN (24), Westminster, Grad. I.A.E., late Rolls-Royce, Ltd., DESIRES APPOINTMENT with Equipment Engineer, Motor Co., or as Assistant to Traffic Manager of 'Bus Co.; disengaged shortly.—Address, P9948, The Engineer Office. P9948 B

FOREMAN BOILERMAKER REQUIRES a CHANGE, England or abroad; vast experience with portable, loco. and vertical boilers, also constructional work; can handle men and fix piecework prices; age 35. Six years in present situation.—Address, P9943, The Engineer Office. P9943 B

PATTERNMAKING.—ADVERTISER (40), Formerly in business as master general patternmaker, DESIRES POST as FOREMAN, home or abroad. Highest qualifications.—Address, P9942, The Engineer Office. P9942 B

PARTNERSHIPS

IF YOU ARE SEEKING
A PARTNER or PARTNERSHIP
or wish to buy or sell a
BUSINESS or WORKS
Write:
WHEATLEY KIRK, PRICE & CO.,
46, Watling Street,
London, E.C. 4.
Established over 70 years.

ESTABLISHED ENGINEERING BUSINESS REQUIRES the SERVICES of competent ENGINEER; must invest £500-£1000. Capital fully secured, every investigation.—Address, P9944, The Engineer Office. P9944 C

PARTNERSHIPS and ACTIVE DIRECTORSHIPS WANTED in Mechanical, Constructional, Electrical Engineers, &c., for Clients with technical experience and capital from £1000 to £20,000.—GILBERT and PRATT, 18, Walbrook, London, E.C. 4. Ex C

£5000.—WANTED, AUSTRALIAN FIRM or GENTLEMAN, engineer preferred, to start MANUFACTURING ARTICLES in universal demand. German and American competition easily beaten. English works running successfully.—Address, P9890, The Engineer Office. P9890 C

EDUCATIONAL

CORRESPONDENCE COURSES for Inst. C.E., Inst. Mech. E., London Univ. (Matric., Inter., B.Sc.), and ALL ENGINEERING EXAMINATIONS, personally conducted by Mr. TREVOR W. PHILLIPS, B.Sc. (Honours) Eng., London, Assoc. M. Inst. C.E., Chartered Civil Engineer, M.R.S.I., F.R.S.A., &c. Also Day Tuition in Office. Excellent results at all Exams., comprising hundreds of Successes. Courses may commence at any time.—Apply to Mr. TREVOR W. PHILLIPS, B.Sc. (Hons.), A.M.I.C.E., &c., 9/11, TRAFFORD CHAMBERS, 48, SOUTH JOHN STREET, LIVERPOOL. Ex. B

ENGINEERING DRAWING.—Special Postal Course in Engineering Drafting. Enrol now. Fee three guineas for the complete course. Also day tuition in office by qualified teacher. Established 1895.—PERCY PITMAN, M.I. Mech. E., 25, Victoria street, London, S.W. 1 7037 B

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JANUARY 2, 1925.—VOL. CXXXIX.

THE ENGINEER.

A Seven-Day Journal

Railways of New Zealand.

IN view of the recent inquiry into their working by Sir Sam Fay and Sir Vincent Raven, the report, just to hand, of the railways of New Zealand during the year ended March 31st last, is of unusual interest. That document shows that when compared with the corresponding period of 1922–23 the net profit rose from £1,225,305 to £1,580,445, and the percentage of profit to capital invested from 3.04 to 3.83; the percentage of working expenditure to earnings fell from 81.79 to 77.37; the average earnings per mile open rose from £2219 to £2291; whilst the working expenses per mile fell from £1813 to £1772, and the net average earnings per mile open rose from £406 to £519 and per train mile from 35.37d. to 42.07d. In the statement by the Minister of Railways it is observed that much valuable material has been collected with regard to the electrification of certain suburban sections. The consensus of opinion has been that the time has not yet arrived to convert any of the lines from steam to electricity. Public agitation continues in various localities, however, for the electrification of suburban sections, and in order to remove as far as possible all doubt as to the wisdom or otherwise of converting any particular section or sections, the Government invited quotations for the cost of furnishing a report with regard to the suburban sections of the four main centres, and many leading firms submitted prices, either to the High Commissioner or directly to the department. It has been decided to obtain a report from Messrs. Merz and McLellan, consulting engineers, London.

Reliability of Motor Cycles.

THE trials organised by the Motor-cycling Club, which came to an end on Saturday evening, December 27th, were noteworthy this year on account of the extreme severity of the weather and the consequent test of the endurance of both riders and machines. The trials took place over the route between London and Exeter, and back, a distance of 337 miles, and included a whole night of driving. There were 370 competitors, on motor cycles, cycles with side cars and light cars. The riders of the motor cycles naturally felt the gale of wind and rain most, and there were frequent spills, through side slips or running into obstructions. In some places the roads were under water. It is noteworthy that 85 per cent. of the starters survived the ordeal, and it is said that among those who abandoned the trials, the reason was generally physical inability to withstand the elements rather than inefficiency on the part of their machines. Another remarkable motor-cycling feat, of which news has just been received, is the traversing of the Libyan Desert by two Cairo riders on machines fitted with sidecars. The distance from Cairo to Siwa and back is about 1200 miles, and it was covered in fourteen days. The ride must have put the transmission gearing of the machines to a very severe test, as half the journey was done on second gear, and over 100 miles required the bottom gear.

Navigating by Wireless.

A NEW type of direction-finding wireless apparatus, introduced by Siemens Brothers, is being tested on the Anchor liner Assyria, which is now on its outward journey from Glasgow to New York. The apparatus is used in conjunction with a rotating frame aerial, and it is designed to give the bearing of any station which may be heard, irrespective of whether the transmitting station is working on the continuous wave or spark system. Although the range naturally varies according to atmospheric and other conditions, it is confidently expected that it will be equal to at least an average day's run. The operation of the apparatus is said to be very simple, notwithstanding that the construction is somewhat complex. The value of direction-finding equipments, especially in areas such as the North Atlantic, where fog is prevalent and solar observations are frequently impossible, is now well recognised. Direction finding also enables navigators to follow their courses closely and to reduce the time taken for a given trip.

Power Station Wages.

THE Whitley Council for the electricity supply industry in the north-western area met again in Manchester last Monday to consider the union's claim for the restoration of the 10 per cent. reduction in wages made in the area in 1923 and for the wages to be brought up to the level of those in other areas. At the close of the meeting, Mr. H. Banks, the employers' secretary, is reported to have said that a settlement had not been reached. Negotiations in the area had, in fact, broken down, and the application would have to go before the National Joint Industrial Council for the industry. Among the employers' reasons for refusing the application was the fact that the average cost of living to-day is the same as that on which the 1923 rates were based, and that an increase of wages could only be met by imposing extra charges on the consumer. In October a special tribunal reported against an all-round increase in the industry, but left the area Councils free to reconsider wage rates, and if a deadlock arose to refer the difference to the National Council. On the other hand, we observe that the employees in the electric supply undertakings affiliated to the West Midlands District Industrial Council are to receive an increase in wages under the sliding scale agreement based on the index figure of the cost of living. A circular letter to the constituent undertakings represented on the Council states that the revision of wages is based upon the average of the cost of living index figures, as published in the Ministry of Labour *Gazette* for the preceding three months.

Air Disaster at Croydon.

AT noon on Wednesday, December 24th, an aeroplane belonging to Imperial Airways, Limited, crashed from a low height a few minutes after leaving Croydon Aerodrome for Paris. The machine, a D H 34, formerly belonging to the Instone Company, was almost immediately destroyed by fire, and all on board, seven passengers and the pilot, lost their lives. The disaster has been described as the worst in the history of British civil aviation, and is the first attended with fatal results that has happened since Imperial Airways took over the operation of the continental services in April, 1924. The machine involved in it, it is reported, had been in use for about three years and had flown nearly 100,000 miles without mishap on its journeys to and from the Continent. Eight machines of the same type have, as a fleet, flown over a million miles in the same service, at an average speed of about 100 miles an hour, and have been involved in only one other mishap, causing death or injury to passengers. The pilot of the wrecked machine was a man of great skill and experience. From the start of the trip it was noticed that the machine was flying unduly low, and that it was apparently experiencing difficulty in battling against the strong wind that was blowing. An Air Ministry inquiry is being held into the cause of the disaster.

Locomotive Draw-bars.

ON December 13th two railwaymen travelling as passengers on the tender footplate of a London, Midland and Scottish goods engine at Crofton were killed as a result of the breaking of the engine draw-bar. When the accident occurred the engine shot ahead of its tender and the men were precipitated on to the line below the oncoming train of wagons. At the inquest last week it was found that the draw-bar had broken at the eye hole end. Mr. Shawcross, of the Horwich works, stated that the engine had been built in September, 1919, and that the draw-bar was one of a batch forged in October, 1918, from slabs cut from blooms used in the manufacture of crank axles. The draw-bar had been heat-treated and inspected, and conformed to the British Standards Association's specification for high-grade forgings with a low percentage of sulphur and phosphorus. Tests conducted on the broken draw-bar showed that the material was sound, but that it had been strain-hardened, and that it had broken under repeated suddenly applied loads. Another railway official admitted that the draw-bar was one of three that had broken within the previous six weeks, and that in the whole of his twenty years' railway experience he had come across only one other case of a broken draw-bar. In returning his verdict, the coroner said that attention should be directed to the provision of increased strength in draw-bars, especially in the neighbourhood of the eye hole, that they should be inspected more strictly and more frequently, and that a definite limit should be set to the limit of wear allowed in them before they were scrapped.

Broadcasting at Sea.

THE reception of wireless concerts on ships is, of course, no longer a novelty, but another scheme has been introduced which, we believe, is quite original so far as ships are concerned. On ocean-going liners music played in the saloon can now be broadcast to various parts of the ship, so that it may be heard practically all over the vessel. The apparatus, which we presume corresponds with that now commonly employed at dinners and so forth, can also be used for broadcasting lectures and for other purposes. The motor ship, the Aorangi, of the Union Steam Ship Company, of New Zealand, of which we begin a description in this issue, and which leaves Southampton on her maiden voyage to Australia to-day, is the first ship to be fitted with the apparatus, but the Canadian Pacific liner Montclare is also being equipped with broadcasting apparatus of this description.

Thornycroft Marine Motors.

AT the annual meeting of John I. Thornycroft and Co., Limited, which took place last week, Sir John Thornycroft announced that it had been decided to transfer the marine motor department from the firm's Basingstoke works in order to set that works entirely free for the manufacture of motor vehicles. New premises for the production of marine motors have been purchased, and it is hoped to begin work in the new factory early in the spring. At the new works the firm's present type of petrol and paraffin engine will be built, and in this connection it is of interest to learn that engines representing over 10,000 brake horse-power were supplied by the firm during 1924. An entirely new development will be the production of an improved type of marine hot-bulb motor of the Thornycroft-Record type, which will be built and sold by Thornycrofts jointly with Robert Heath and Lowmoor, Limited, of Bradford. This engine as originally designed was described in THE ENGINEER of September 21st, 1923. It is of the solid injection type, with two parallel working cylinders mounted on the top of a common pump cylinder. The arrangement of the cylinders is such that although the engine works on the two-stroke principle, crank case compression is avoided. The design has several features which especially fit it for marine use.

The Shipbuilding Outlook.

WRITING in the 1924 review of shipping, shipbuilding and commerce, published by Lloyd's List, Sir Frederick Henderson, of D. and W. Henderson and Co., Limited, Partick, Glasgow, deals with the present outlook in the British shipbuilding industry. Even though the most optimistic view of things be taken, he finds little in the situation to encourage the belief that there will be a speedy recovery in the industry. In his opinion, both employers and shipyard workers have still a lean time ahead. A further disturbing factor is, he says, the inelasticity of the trade union mentality, which seems to make it difficult to adjust wages and conditions, so that the employer can effect any real economy by installing new plant and machinery, even though that economy may be realised without affecting adversely the actual earnings of the men. As an instance of this, Sir Frederick cites the case of pneumatic tools, which in some British yards have tended to add to the cost of shipbuilding rather than to lessen it.

The British Steam Railway Locomotive from 1825 to 1924.

By E. L. AHRONS, M.I. Mech. E.

No. I.

IT is not the intention of the writer to deal with the history of the locomotive from the very beginning, but to start with its first employment on a public railway and thence follow its gradual development during the century which has passed since the formal opening of the Stockton and Darlington Railway on September 27th, 1825. For this reason the early work of Richard Trevithick, of Murray and Blenkinsop, of Hedley and Timothy Hackworth at Wylam, and of George Stephenson at Killingworth, will not be described. For an account of this early period reference can be made to some of the books which have been published on the subject, including two which are of quite recent date (1923), viz.—"A Century of Locomotive Building by Robert Stephenson and Co., 1823–1923," by J. G. H. Warren, and "Timothy Hackworth and the Locomotive," by Robert Young, M. I. Mech. E.

Moreover, space will not permit of an account of the interesting and important developments peculiar to the Continent of Europe, and the United States of America, and, therefore, the history of locomotive progress and design will be confined to British railways and those in the Overseas Dominions of the Empire, though account will be taken of the great work which has been done by the private locomotive-building firms of this country for abroad. For many years locomotive progress was almost entirely dependent upon the private builders, who to this day continue to produce and develop new designs for overseas countries almost throughout the world, to suit special conditions which do not exist in Great Britain.

PERIOD 1825–27.

When the Stockton and Darlington—the first public railway in the world—was opened, there was but one locomotive, the celebrated "Locomotion No. 1," which had been delivered in September, 1825, by R. Stephenson and Co., from their Forth-street Works, Newcastle. The evening before the public opening of the line on September 27th, it made a trial run from Shildon to Darlington with a party of the "Committee," as the directors were then termed. They were accompanied by George Stephenson, whose elder brother James drove the engine.

The Locomotion, as it now exists after sundry alterations, is shown in Fig. 1, and may be described as the Stephenson Killingworth type of engine with certain modifications. The wrought iron boiler, 10ft. 4in. long by 4ft. diameter and of ⅜in. plates, was of the single through flue type, the flue being 2ft. diameter. At the front the flue was continued upwards as a chimney. There were two vertical cylinders, each 9½in. by 24in., the lower portions of which were placed inside the boiler. Each cylinder was placed vertically above the centre of the wheel, to which its connecting-rods were attached. The piston-rods issued from the tops of the cylinders, and the two crossheads, which were guided by half beam parallel motions, extended across the top of the boiler to form the connections to four long connecting-rods, two on each side of the engine. The late Joseph Tomlinson[1] stated that "the pistons were packed with a spun yarn gasket, plaited square, which was tightened by a piece of wood and a hammer." Warren[2] adds that the drive from the cylinders and the half beam parallel motion "appear to be a retrogression from the more simple construction of the Killingworth and Hetton engines." In the engine as now preserved at Darlington there is a single excentric for both fore and back gear of both slide valves. This excentric had a notch plate or reversing disc at the side, and was driven by a lug on the wheel. The main excentric rod was carried upwards in a vertical direction to drive the valve of the front cylinder, and a second rod from the same excentric passed horizontally to a bell crank lever for driving the valve of the rear cylinder. —Fig. 2[3] Connected to the valve spindles were two starting handles, by means of which the driver could disengage the excentric rods from the valve-rocking levers, and move the latter by hand to start the engine. The disengagement was effected by means of a sliding catch on the end of each excentric rod, which was released when the engine had to be reversed. When the engine was in motion the catch was engaged.

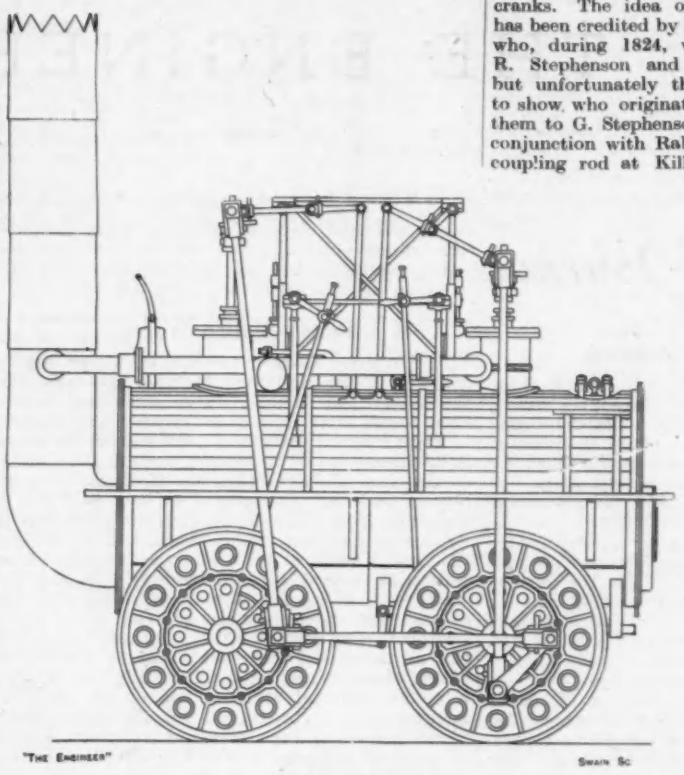


FIG. 2—"LOCOMOTION NO. 1"

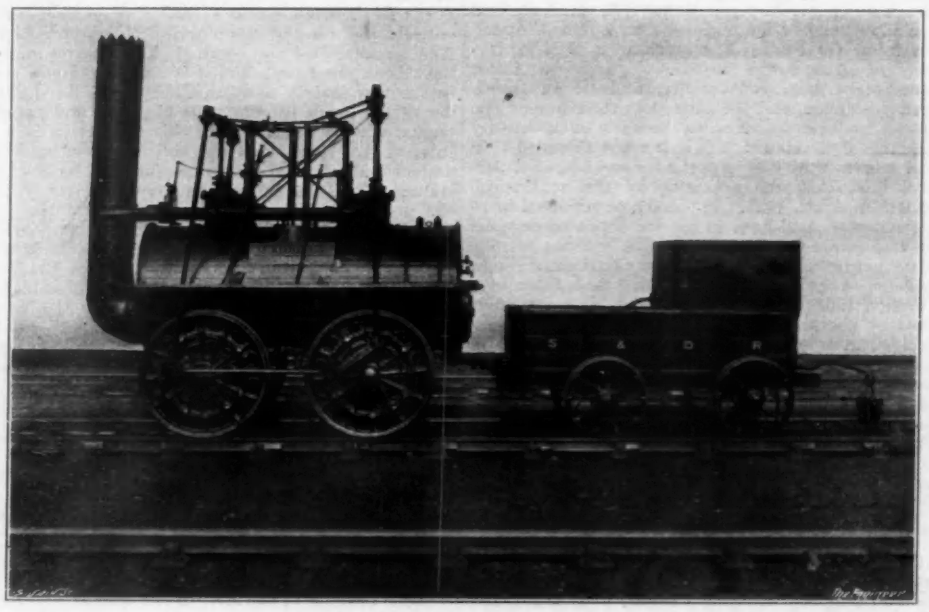


FIG. 1—"LOCOMOTION NO. 1"—STOCKTON AND DARLINGTON RAILWAY

The original valve gear of some of the first four Stockton and Darlington locomotives may have been slightly different[4].

The four wheels were 4ft. diameter, and the axles revolved in cast iron plummer blocks, but in the original design one axle worked inside an iron tube, to the middle of which a bracket supporting the boiler was fixed with the probable intention of providing a three-point support for the engine. There were no bearing springs, though Nicholas Wood at about this time applied springs to the Killingworth engines.

One of the interesting features was the arrangement of cranks and coupling rods. The cranks of each pair of wheels being worked from one cylinder, were necessarily parallel, but were placed at 90 deg. with those of the other pair of wheels, the front cranks leading. Direct outside coupling rods were used, the pins for the back end being fixed in return cranks. The idea of these outside coupling rods has been credited by his son to Timothy Hackworth, who, during 1824, was temporarily employed by R. Stephenson and Co., at Forth-street Works, but unfortunately there is no documentary proof to show who originated them. D. K. Clark ascribed them to G. Stephenson, and certainly the latter, in conjunction with Ralph Dodds, had used an inside coupling rod at Killingworth in 1815. The coupling rod pins, as shown in the earliest original drawing[5] in the possession of R. Stephenson and Co., were spherical. Even in these early days the lateral displacement of one coupled axle with respect to the other was foreseen and provided for. Spherical pins, of which we shall meet with several examples, are rarely used now in this country, but they are common on the European Continent, more especially in the front coupled wheels of engines provided with combined bogies of the Krauss-Helmholtz type. The framing was of cast iron.

The boiler carried 50 lb. pressure and had a heating surface of about 60 square feet. The figures in regard to pressure are somewhat contradictory. In Newton's "London Journal," Vol. 10, 1825, it is stated that "the steam pressure was 30 lb., and the safety valve was loaded to 50 lb. per sq. in." The Prussian engineers, who visited the railway in 1827, gave the pressure as 52 lb. Joseph Tomlinson stated that when first put to work it would not steam, and that the fire tube had to be replaced by a return flue. The weight in working order of the original engine was about 6½ tons, according to the description plate now on the engine, but this appears to be incorrect. Mr. A. C. Stamer, Chief Assistant Mechanical Engineer, London and North-Eastern Railway, has recently weighed the engine and found the figures to be 8 tons 8 cwt. full and 6 tons 16 cwt. light. The tender ran on four wheels, the frame being of wood with a sheet iron tank. Tomlinson refers to two tenders, which were usual with many of the early Stockton and Darlington engines, but the second tender must have been a subsequent addition when the boiler was altered to the return flue type.

The cast iron wheels shown in the illustration were of Hackworth's design, and added at a later date.

Three other engines, 2 Hope, 3 Black Diamond and 4 Diligence, were supplied by Messrs. Stephenson to the Stockton and Darlington Railway between November, 1825, and May, 1826. The Locomotion had an adventurous career. The boiler exploded in July, 1828, after which the locomotive was rebuilt by T. Hackworth at the company's workshops at Shildon. He gave ita new boiler, with a single flue and two return tubes, but subsequently a third boiler with single flue of the original design was supplied, and in this form the engine finished its working career. It continued in service on the railway until 1841, but appears to have been called upon to officiate on festive occasions, such as the opening of the Middlesbrough and Redcar line in 1846, when it headed the procession. For some years it was used by Messrs. Pease and Partners as a pumping engine, and in 1857 was placed on a pedestal near North-road Station, Darlington. On the occasion of the Jubilee of the Stockton and Darlington Railway in September, 1875, it was again in steam. In 1876 it visited the Philadelphia Exhibition, and in 1881 appeared in the procession of locomotives at the Stephenson Centenary. Finally it was shown at the Liverpool Exhibition of 1876 and the Paris Exhibition of 1889, and in 1892 was placed in its present position in Bank Top Station, Darlington.

It may be added here that the plate affixed to the engine gives the boiler pressure as 25 lb. per square inch, which may have been the load on the safety valves in its later days. The records also show that the cylinders had been enlarged to 10in. diameter.

Wilson's Four-cylinder Locomotive, Stockton and Darlington Railway.—A fifth locomotive on the Stock-

ton and Darlington Railway was built by Robert Wilson of Gateshead. Colburn ("Locomotive Engineering," page 21) described it as an engine with four cylinders, two to each pair of wheels, and adds that it appears to have been the first in which each pair of wheels was worked by two pistons acting upon cranks at right angles to each other. But the putting into shape of an excellent idea seems to have been faulty. W. W. Tomlinson, in his "History of the North-Eastern Railway," stated that though the engine "worked unsatisfactorily when on trial, it had been purchased for a small sum for the sake of its boiler and then laid aside." Nothing more seems to be known of this engine, of which the boiler was afterwards utilised for Hackworth's Royal George of 1827.

Stephenson's Experiment, Stockton and Darlington Railway.—The Stockton and Darlington Railway engine No. 6, Experiment, was stated to have been delivered by R. Stephenson and Co. in March, 1827. This is the date given by Tomlinson in his "History of the North-Eastern Railway," but Messrs. Stephenson have no record of the delivery, and Hackworth's notebook records the date as January, 1828.[6] But it was certainly built early in 1827, as it was then seen and fully described by two Prussian engineers who visited Stephenson's works.[7] It originally ran on four wheels, but in 1828 was altered to a six wheels coupled engine.

The main features of this remarkable locomotive were as follows:—It was the first to have two horizontal cylinders; they were placed within the boiler with back covers almost flush with the fire end. The piston-rods were attached to swinging lever arms, which caused a transverse rocking shaft above them to oscillate. Other levers on this shaft were coupled to the connecting-rods, which drove the crank pins on the leading wheels.

The boiler had a single flue and the fire-grate consisted of water tubes, which could be cleaned through a cast iron box at the back. At the front or chimney end they opened into a drum placed inside the flue, which extended forward to the chimney. The drum was in communication with the boiler by means of a rectangular opening through the upper part of the combustion chamber. The boiler was also connected with the cast iron box by two pipes. It resulted that the portion of the flue through which the hot gases passed formed an annular ring round the drum, and water circulated through the boiler, drum, and grate bars. The exhaust steam passed through the boiler towards the chimney, but before being discharged into the atmosphere, part of it passed through a feed-water heating tank. This is the earliest known example of a locomotive with such an appliance, though it is within the bounds of possibility that Trevithick's Pen-y-darran locomotive may have had one on the principle shown in Farey's drawing[8] of his stationary engines, which appear to have been generally provided with a cylindrical heating vessel through which the exhaust pipe passed on its way to the chimney.

In 1830 the Experiment was entirely remodelled by Timothy Hackworth, with return flue, and the engine was then fashioned after the construction of the Royal George.[9]

The burden of the locomotive working of the Stockton and Darlington Railway between 1825 and 1827 had to be borne by the four engines of the "Locomotion" class, and disquieting reports with regard to the success of this new form of motive power began to circulate. The directors were stated to have seriously considered the question of abandoning locomotives altogether. Had this occurred, the success of railway transport would have been seriously jeopardised, and the clock of progress put back many years. The true circumstances, whatever their nature, have formed the subject of acrimonious controversy in the past. To form a sound judgment those interested should consult "The North-Eastern Railway," by W. W. Tomlinson (pp. 140–142), and "A Century of Locomotive Building by Robert Stephenson and Co.," by J. G. H. Warren, on the one side, and "Timothy Hackworth and the Locomotive," by R. Young, on the other. In all of these many original documents are quoted.

There are, however, certain points which occur to the unprejudiced reader of locomotive history. The four early Stockton and Darlington Railway engines by Stephenson were necessarily constructed without previous experience of the arduous requirements of a public railway much longer than the short colliery lines hitherto in use, and it was to be expected that defects would be found in complicated locomotives working under new and extremely defective traffic conditions. Moreover, the engine drivers were rough and not specially trained men, such as those with whom we are now familiar, and they could not be expected to handle their engines with the necessary care. The locomotive builders would be informed of defects one by one as they were discovered, and then only after the engines had left their hands, too late to make the necessary alterations and improvements. The responsibility—no light one—of carrying on the traffic lay with Timothy Hackworth, who had been appointed locomotive superintendent of the railway before it was opened for traffic. It has been said that the modern locomotive superintendent "has to sleep with his boilers." Hackworth alone, and without the skilled assistance given to his modern successor, had to "sleep" with the whole of his engines, and his task was no sinecure. He was the man, a part of whose duties consisted in investigating reports and causes of failures, and he, and not Robert Stephenson and Co., had the first opportunity of finding the remedies. It was in the keen observation which he brought to bear upon the working of the details of the locomotives and engines under his charge which made Hackworth the excellent practical locomotive superintendent which he undoubtedly was. Whilst giving Hackworth all the credit justly due to him, there is not the least justification for belittling the work of Robert Stephenson and Co., because they did not at once turn out a perfect locomotive. That improvements were soon found to be necessary is obvious, but there is no evidence for the statement which has been made that but for unfair influences locomotives "would have been abandoned long before an experimental period of eighteen months had been allowed."

The heating surface, about 60 square feet only, of the single-flue boilers was too small, though the whole of it was furnace and "combustion chamber" surface, which gave a high evaporation per square foot. The boiler had the advantage of cheapness in first cost, and, unlike the engines with return flue boilers, two tenders were not necessary. But the type of boiler was not economical; though whether the saving of fuel at that time was considered of much importance is doubtful.

Hackworth's Stockton and Darlington Railway Engine Royal George.—In September, 1827, Timothy Hackworth constructed at the railway works at Shildon his new engine Royal George. The boiler was 13ft. long by 4ft. 4in. diameter, and contained an internal U-shaped return flue 2ft. 2in. diameter at the furnace or front end, reduced to 1ft. 6in. diameter at the same end, where it terminated at the chimney. The greatly increased heating surface, due partly to the return flue and partly to the larger boiler, was 141 square

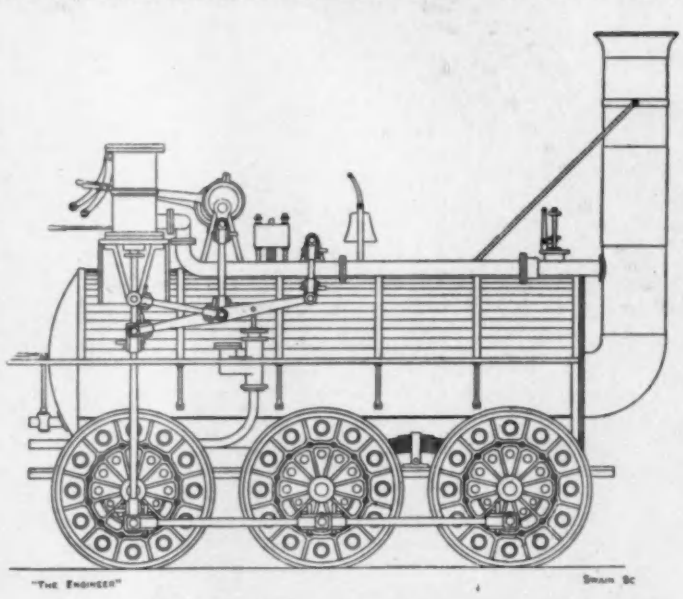


FIG. 3—THE "ROYAL GEORGE"—STOCKTON AND DARLINGTON RAILWAY

feet, or more than twice that of the Locomotion. The pressure was 52 lb. per square inch, at which the spring-loaded safety valve was set, though the lever valve began to blow off at 48 lb. The return flue type of boiler was not new, and had been used in Trevithick's engines. The vertical cylinders, 11in. by 20in., were placed one on each side at the back of the engine, and the pistons working downwards were connected directly to the trailing pair of wheels. This form of direct drive was a great improvement upon Trevithick's indirect arrangement, as used on the small Catch-me-who-can locomotive, in which a single cylinder only was used, though the connecting-rods were coupled to pins in the driving wheels.[10] The Royal George had no slide bars, the pistons being guided by parallel motion, which worked a valve shaft on which two loose excentrics were fixed. From these, both slide valves and reversing were operated. At a later date the valve gear was altered and the excentrics placed on the driving axle. The three axles were coupled to distribute the weight on the rails more evenly, and the engine was the first to have six wheels[11] coupled by means of the usual form of outside coupling rods. The wheels were 4ft. diameter, of cast iron, and of the peculiar pattern long afterwards a feature of Hackworth's engines. They were made in two parts, owing to the lack of lathes at Shildon large enough to turn up the rims when fixed on the axles.[12] The outer rim was trued to the machined centre, and fixed tightly by wood plugs and iron wedges. The large number of holes were made to ensure sound castings and reduce the weight. The front pairs of wheels were connected on each side by a single longitudinal laminated spring,[13] as shown in Fig. 3, but the trailing wheels, owing to their direct connection with the vertically moving pistons, were springless.

A portion of the exhaust steam was turned into a cistern for heating the feed water, but this arrangement had previously been used in Stephenson's "Experiment" locomotive. In the Royal George, the cistern was connected with the tender tank, and the driver could regulate both exhaust and water supply. Novel features included a short-stroke feed pump worked by an excentric, and self-lubricating bearings. The safety valves were of the direct spring-loaded form, but the first application of these to locomotives was made before 1815 by Fenton, Murray and Wood to Blenkinsop's rack rail engines at Leeds.[14] In the latter case, spiral springs appear to have been used, but Hackworth employed elliptical leaf springs. The latter design of spring-loaded valve was new, and for about twenty-five years was generally used on locomotives. The Royal George was the first engine to be provided with a contracted orifice to the blast pipe.

The engine was undoubtedly a successful locomotive, and the most powerful constructed up to that time. Hackworth had put to good account the experience he had gained in his daily observation of the working of the engines under his charge.

The Blast Pipe.—The subject of the blast pipe, the invention of which is still debated, cannot be passed over in any historical account of the locomotive. In the following analysis, the writer has attempted impartially to set forth the salient points.

In February, 1804, Richard Trevithick's rail locomotive was tried at Pen-y-darran, near Merthyr. Very little that is authentic is known about this engine, but the existence of one detail is definitely established. Writing to David Giddy, generally known as Gilbert, who was afterwards President of the Royal Society, Trevithick, on February 20th, stated that the discharged steam was turned up the chimney, and that "the fire burns much better when the steam goes up the chimney than when the engine is idle." On March 4th he wrote that the steam "makes the draught much stronger by going up the chimney." Subsequently, Gilbert examined the engine and wrote to William Nicholson[15] that the waste steam was discharged *upwards* into the chimney about 1ft. above its junction with the boiler. Several persons observed that the fire brightened at each stroke of the piston. Trevithick himself, in his evidence before the Committee of the House of Commons in 1831 on "Steam Carriages," stated that he used a "force-draught" created by the steam, for the purpose of working on the roads without a high chimney.

An existing memorandum by Simon Goodrich contains a pencil sketch[16] of another Trevithick engine for driving a coach. The sketch was probably made in 1803, and shows an exhaust pipe going to the chimney, but does not show whether it was turned up inside the latter.

It is true that John Farey[17] in his evidence before the above-mentioned Committee, stated that "the waste steam was commonly discharged into the bottom of the chimney in Trevithick's high-pressure engines . . . but was not discharged through a contracted orifice to give it velocity, nor was it directed upwards, as is now done by Mr. Stephenson." Farey appears to have been referring to Trevithick's stationary engine practice, and in Rees's "Cyclopædia" (1819), his sectional drawing showing the exhaust pipe not turned upwards is described as that of the dredger engine. But in any case, Gilbert's evidence in regard to the Pen-y-darran locomotive is conclusive.

Trevithick's exhaust pipe was so arranged that it produced a "blast" with consequent draught on the fire. It matters not whether it was subsequently termed an "exhausting" or an "eduction" pipe. The effect was there in nature and quality. It has been argued[18] that no mention of the blast pipe was made in Trevithick and Vivian's 1802 patent, and that therefore Trevithick did not comprehend the significance of the blast. But the Pen-y-darran locomotive was not made until the end of 1803, and did not start work until February, 1804. The effect of the exhaust was not discovered until the latter date, but it was immediately noted by Trevithick as soon as the engine started work, and was considered of sufficient importance to merit special mention in both letters to Gilbert.

We now go north to Wylam Colliery, for which Blackett had a locomotive constructed of Trevithick's design. It was built at Whinfield's Foundry, Gateshead, under the superintendence of John Steel,[19] between October, 1804, and May, 1805. W. W. Tomlinson[20], giving as a reference the *Newcastle Courant*, June 3rd, 1815, states that Trevithick sent drawings and patterns to John Whinfield, whom he had

appointed his agent for the North of England in 1803, and commissioned the latter to manufacture the engine. John Steel was stated to have worked at Pen-y-darran on the construction of the Merthyr locomotive, and the drawings, from which the Gateshead engine was actually built, may have been made by the latter from Trevithick's particulars. That Trevithick had an intimate connection with it, is proved by his visit to Newcastle in 1804, and his reference to an intended further visit in February, 1805. The important point is that if the engine was built in accordance with Trevithick's plans and instructions it would certainly have been provided with the chimney exhaust which he always employed. Moreover, John Steel could hardly have failed to note the exhaust arrangement of the Pen-y-darran locomotive, though the Gateshead drawing shows no exhaust pipe.[21] This locomotive was tried in steam in the foundry yard, but Mr. Blackett, for some unknown reason, did not accept it at Wylam.

The exhaust pipe in the chimney was stated to have been applied in 1813 by Hedley to the first of the Wylam-built Grasshopper engine, which was put into service in May, 1813, and it was stated that "the blast was added soon after the engine commenced work."[22] The exhausts from the two cylinders were combined into one pipe which passed into the chimney. It is impossible to state definitely that the chimney exhaust was copied from Trevithick's locomotives, of which both Blackett and Hedley must have had some knowledge. But Gilbert's observations had been published by Nicholson, and the latter had taken out a patent, so that, as Colburn pointed out, "the action of the exhaust steam in the chimney of a locomotive was well known in 1813." Blackett was constantly on the look-out for anything which would assist steam locomotion, and it would be surprising to find that he had not heard of it. On the other hand, if the "blast" was added subsequently, as is implied by Archer's statement, it would appear that the exhaust was at first turned into the atmosphere, and later, to get rid of the nuisance, into the chimney. This points in the direction that Trevithick's lessons had not been learnt and to a "rediscovery" of the effect of the blast, similar to that made more than nine years previously. Apparently very little "blast" was necessary in these return flue engines, since the arrangement was again altered and the steam turned into a cylindrical silencer, whence it passed gradually into the chimney. This later method was certainly not a "blast," as the steam jet action was thereby suppressed in order to reduce the noise.

In George Stephenson's first Killingworth locomotive of 1814, the exhaust, according to Colburn, does not appear to have been turned into the chimney. But in 1815 it was so directed, and Nicholas Wood, in 1825,[23] wrote :—"To effect a greater rapidity, or to increase the draught of the chimney, Mr. Stephenson thought that by causing the steam to escape into the chimney through a pipe with its end turned upwards, the velocity of the current would be accelerated, and such was the effect." Wood's statement is a sufficient reply to those who afterwards asserted that Stephenson before 1827 did not understand the effect of the exhaust pipe, otherwise the blast, in stimulating the fire. It has sometimes been forgotten that in the early locomotive with single and even return flue boilers very little blast could be used with success. A blast of the force with which we now visualise it in connection with multitubular boilers would have pulled most of the fire up the chimney.

In the 1815 engine Stephenson, according to Wood's illustration, used a single pipe into which the exhausts from both cylinders were led. In the Stockton and Darlington engines of 1825–6 the exhaust from each cylinder was taken independently to the chimney, in which the two pipes were turned up, one at each side.

It is not reasonable to maintain that two separate exhaust pipes cannot be regarded as blast pipes, though the quantitative effect, as measured by the volume of entrained gases, may be different. Such double blast pipes were used on locomotives long after Mr. J. W. Hackworth started the "battle of the blast pipe" in THE ENGINEER of 1857, in which he made a special point of this question. The Grant Locomotive Works, U.S.A., used double blast pipes successfully, and an illustration of one is given in Formey's "Catechism of the Locomotive," 1883 edition, Fig. 95, page 168. A blast pipe by Heusinger v. Waldegg used in Germany had a partition which completely separated the right and left-hand exhausts. In neither of these cases was either exhaust central with the chimney. It is true that the experience of locomotive engineers throughout the world has proved the single central exhaust to be the better, and the reasons why were clearly demonstrated by the experiments of Dr. Goss at Purdue University.

Who was the first to place the blast pipe orifice centrally with the chimney? Timothy Hackworth did so in the Royal George of 1827, and his claim was vigorously put forward by J. W. Hackworth in 1857, though the latter did not support it with independent evidence that the central position had not been used previously. On the other hand, in 1830, Robert Stephenson[24] wrote that an increase in the temperature of the fire "was effected, shortly after the first locomotive engine was tried on the Killingworth Colliery Railway, by conveying the steam into the chimney, where it escaped in a perpendicular direction up the centre. . . ." Here also there is no independent evidence, though it should be added that in 1830 R. Stephenson was writing of an arrangement which had been applied not many years previously, whereas in 1857 J. W. Hackworth was writing of events which took place when he was only seven years old.

It is not unlikely that Trevithick's Pen-y-darran locomotive may have had a central exhaust orifice, for the reason that all known drawings of his locomotives show chimneys of small diameter, in which a turned-up pipe would necessarily be in or nearly in that position. Similarly the chimneys of the Wylam engines were of moderate diameter, and there is no evidence that a central exhaust was not used there in 1813.

The credit for coning or tapering the blast pipe to form a contracted orifice is undoubtedly due to Timothy Hackworth in 1827, and was acknowledged by Robert Stephenson himself.[25]

To sum up: All the available evidence goes to show that the blast pipe was not *invented* by any one, but was an accidental discovery by Richard Trevithick, and its effect was known in 1804. It was either copied, or independently rediscovered in the same accidental manner, first at Wylam, where Timothy Hackworth was then employed, and then shortly afterwards by George Stephenson. The question as to the priority of placing the upturned pipe centrally with the chimney cannot, so far, be definitely answered. The final improvement of the contracted orifice in so far as it was applied to an exhaust steam or blast pipe, was Timothy Hackworth's, and this improved form of blast pipe may fairly be described as an invention.[26]

[1] Presidential address, Inst. Mech. Engrs., 1890.
[2] "A Century of Locomotive Building," by Robert Stephenson and Co., 1823–1923," by J. G. H. Warren. Further references to this book will, to save space, be quoted under the name "Warren."
[3] Taken from THE ENGINEER of July 16th, 1920: Dunlop on "The Development of Locomotive Valve Gears."
[4] For valve gear, Warren, drawing, page 114, and description, page 119, from a report of two Prussian engineers on the Stockton and Darlington Railway engines.
[5] Warren, page 114.
[6] "Timothy Hackworth and the Locomotive," by Robert Young, in which some particulars of the engine may be found. The general description of the engine given above has been abridged from Warren, pages 120–125, in which a full account and sketches by J. U. Rastrick are given.
[7] Warren, page 120.
[8] Ree's "Cyclopædia," 1819. Also Hebert's "Engineer's and Mechanic's Encyclopædia," 1849.
[9] "Timothy Hackworth and the Locomotive," page 165.
[10] A similar arrangement to this was applied by Dodds and Stephenson in 1815.
[11] Dodds and Stephenson's six-wheeled engine of 1815 had two axles coupled by inside coupling rods, but the middle and third axles were coupled by chains. See Warren, pages 22 to 24.
[12] "Timothy Hackworth and the Locomotive," page 158.
[13] Some doubt has been expressed as to whether these springs were not fitted some months after the engine was built. See Young, page 387; also Warren, page 123. Plate springs appear to have been first used by Nicholas Wood at Killingworth.
[14] THE ENGINEER, April 29th, 1910, page 432.
[15] Nicholson's "Journal," September, 1805, Vol. XII., pages 1 and 2. Colburn, "Locomotive Engineering," pages 13–15.
[16] Contributed to the *Journal* of the Newcomen Society, Vol. I. (1920–1), by Mr. E. A. Forward, A.R.C.S., of the Science Museum, South Kensington.
[17] Quoted in "A Century of Locomotive Building by Robert Stephenson and Co.," by J. G. H. Warren, page 224.
[18] "Timothy Hackworth and the Locomotive," page 214.
[19] Nicholas Wood "On Railroads," 1st edition, page 130, states that the engine was built by Trevithick and sent north.
[20] "The North-Eastern Railway: Its Rise and Development," pages 19, 20.
[21] "Timothy Hackworth and the Locomotive," page 38.
[22] "William Hedley, the Inventor of Railway Locomotion," by M. Archer, third edition, footnote page 11. The whole history of the first Blackett-Hedley engines is very unsatisfactory.
[23] "Practical Treatise on Railroads," 1825 edition. A copy of the page containing the complete statement is given in Warren's book, page 26.
[24] "Observations on the Comparative Merits of Locomotive and Fixed Engines," Robert Stephenson and Joseph Locke. The complete quotation is given in Warren's book, page 225.
[25] R. Stephenson's letter to S. Smiles, written in 1858, is quoted in full in J. G. H. Warren's book, page 227.
[26] The sketches attached to Nicholson's patent of 1806 show a *tapered* orifice, from which a jet of *live* steam issued.

Motor Ships and Marine Oil Engines in 1924.

FOR the year which has just ended we have to chronicle remarkable progress in the number of motor ships built and the general development of the marine oil engine; indeed, the year was one which for this reason alone will leave its mark in the history of marine engineering. There was a steady growth in the world's proportion of motor vessels as compared with steamships, and up to the last quarter of the year the orders placed for motor ships more than equalled those for vessels propelled by steam engines and turbines. The remarkable position referred to takes into account the continental developments, especially those relating to German and Scandinavian shipbuilding programmes, which include none, or very few, steamships. In Great Britain the proportion of motor to steam vessels, though not so large, was nevertheless increased, and some notable ships were completed and begun. Not only was there a large increase in the number of motor ships built by British shipbuilding yards during the year, but the size of vessels fitted with marine oil engines was materially increased. At the time of writing the Union Steam Ship Company's 17,500-ton motor liner Aorangi, the largest and finest vessel of her type, is about to start on her maiden voyage, and the first of our articles describing her appears elsewhere in these pages. At Belfast and on the Tyne other motor liners which will extend the field of the motor vessel in new directions are under construction. It may be truly said that the day of the large motor liner has arrived.

Apart from the increase in size of vessels and the total power of propelling machinery installed, notable advance was made in standardisation of oil engines and the construction of single-screw units, which demonstrated the reliability and economy of this type of internal combustion machinery. Finally, steady progress was made towards the production of a double-acting engine, which by reason of its smaller weight, lower capital cost, and less space required, will increase the economy of the small-powered motor-driven vessel.

The trend of development to which we have referred concerns not alone the four-cycle engine, but also the two-cycle and the opposed-piston types of prime mover. We have always taken the view that these different forms of marine oil engine were complementary in character, and that the interests of the marine engineering industry would best be served by a quick and intense development of the possibilities of each design rather than destructive criticism and undue rivalry. The progress of the year may be conveniently summed up by a consideration of what was accomplished with each type of engine, but before doing that we may refer here to the total number of ships which were launched and completed within the period under review.

In our issue of January 2nd of last year tables were given showing the steady increase in the number of ships completed in the years 1920 to 1923. We summarise the figures then given and add those of 1924 in Table I. accompanying this article, from which

TABLE I.—*Vessels of 1000 Gross Tons and Upwards Fitted with Marine Oil Engines Completed in Great Britain and Ireland during the Year.*

Particulars.	1920.	1921.	1922.	1923.	1924.
Number of motor ships launched and completed	7	15	17	14	43
Total gross tonnage in tons	53,407	83,989	114,527	78,862	231,764
Total horse-power of propelling machinery in I.H.P.	31,140	42,860	69,820	49,137	145,130

it will be seen that forty-three motor ships were finished during 1924, representing an aggregate of 231,764 gross tons and a total of 145,130 indicated horse-power, as compared with the fourteen ships of 1923. We have purposely omitted from our table ships approaching completion, even though in some cases the machinery was built and tested, but was not installed. As in the case of last year, some of these vessels will appear in next year's returns.

For the convenience of our readers we give in tabular form on page 5 full hull and machinery particulars of forty-two ships built. They have been compiled as accurately as possible from classification particulars and returns supplied to us by the owners and builders.

Four-stroke Single-acting Engines.

As in previous years, the four-stroke single-acting engine takes the first place as regards the number of engines built and installed, and in what follows a brief *résumé* of the advances made with that type of propelling machinery is given.

Harland and Wolff-Burmeister and Wain Type.—The lead which was established in the early years of motor shipbuilding by the Burmeister and Wain type of engine has been more than maintained, and the well-tried original design has now been varied and new features added, enabling it to meet new conditions of operation, while standard units for almost every type of mercantile ship have been evolved. We are informed that over 800,000 gross tons of ocean-going shipping are to-day fitted with such engines, and to this figure must be added the 500,000 tons which are now under construction. Standard ships of the year built by Harland and Wolff include six twin-screw vessels for the Bank Line, which were built at the firm's Govan yard; while in addition to a twin-screw vessel for the Glen Line, the Glenshiel, another fine twin-screw ship, the Lochmonar, was completed for the Royal Mail Steamship Company, Limited. Interesting single-screw ships were those built to the order of Andrew Weir and Co., which include the Gujarat, delivered at the end of 1923, and the Kathiawar and Luxmi, completed last year. These last-named ships are a good example of Harland and Wolff's practice with regard to single-screw installations, and the long-stroke, slow-speed type of engine employed is economical in running and upkeep, and it leaves nothing to be desired in its excellent manœuvring capabilities. Besides ships completed, sets of machinery were constructed by the firm for the Elmworth and Oakworth, 400ft. single-screw cargo vessels for the Dalgleish Steam Shipping Company,

SOME BRITISH MOTOR SHIPS AND MARINE OIL ENGINES OF 1924.

TABLE II.

Name of vessel.	Hull particulars.				Builders.	Owners.	Type of propelling machinery.	Main engine particulars.				Auxiliary machinery.	Remarks.
	Length	Breadth	Depth	Gross tonnage				Bore.	Stroke.	R. p.m.	Total B.H.P.		
	Feet.	Feet.	Feet.					Inches.	Inches.				
Aorangi	600	72	46.5	17,500	Fairfield Shipbuilding and Engineering Co., Ltd.	Union Steam Ship Co., Ltd., of New Zealand	Quadruple-screw, six-cylinder, two-cycle, single-acting, Fairfield-Sulzer type	27½	39	127	13,500	Diesel-electric, four 300 K.W. Sulzer-Allen generator sets and three Brown-Boveri turbo-blowers	Completed
Asuka Maru	440	57.3	35.5	7,488	D. and W. Henderson, Ltd., and Harland and Wolff, Ltd.	Nippon Yusen Kaisha	Twin-screw, eight-cylinder, four-cycle, single-acting, Harland and Wolff B. and W. type	26½	43 5/16	125	4,000	Diesel-electric, three 100 K.W., 300 r.p.m. generating sets	Completed
Atago Maru	440	57.2	35.8	7,500	Lithgows, Ltd., and Sulzer Bros.	Nippon Yusen Kaisha	Twin-screw, four-cylinder, two-cycle, single-acting Sulzer type	26½	47¼	100	4,000	Diesel-electric, three 125 K.W. Sulzer airless injection generating sets and Brown-Boveri turbo-blowers	Machinery installed by David Rowan and Co., Ltd., Glasgow. Completed
Baron Dalmeny ..	348.5	49.9	26.5	3,535	William Hamilton, Ltd., and David Rowan and Co., Ltd.	H. Hogarth and Sons	Single-screw, six-cylinder, Rowan-Camellaird-Fullagar opposed-piston type	18½	2×25	100	1,500	Diesel-electric, two Plenty hot-bulb engines	Completed
Boldis	302.8	45.3	21 6	2,046	Sir W. G. Armstrong, Whitworth and Co., Ltd.	Christen Smith's Rederi	Single-screw, four-cylinder, two-cycle, single-acting, Armstrong-Sulzer type	23½	41½	110	1,350	Steam-driven engine-room and deck auxiliaries	Completed
British Aviator	440.2	57	33.8	6,998	Palmer's Shipbuilding and Iron Co., Ltd.	British Tankers, Ltd.	Single-screw, six-cylinder, Palmer-Camellaird-Fullagar opposed-piston type	23	2×36	90	3,000	Diesel-electric, two Polar-Metropolitan-Vickers 60 K.W. generating sets	Completed
British Motorist	440	57	33.8	6,824	Swan, Hunter and Wigham Richardson, Ltd.	British Tankers, Ltd.	Single-screw, eight-cylinder, two-cycle, single-acting, Neptune type	24	50	80	3,200	Diesel-electric and steam auxiliaries ..	Completed
Centaur	315.7	48.2	21.3	3,066	Scott's Shipbuilding and Engineering Co., Ltd., and Burmeister and Wain	Straits Steamship Co., Ltd. ..	Single-screw, six-cylinder, single-acting, long-stroke, four-cycle, Burmeister and Wain type	24½	51 5/16	110	1,500	Diesel-electric, three 100 K.W. Burmeister and Wain generating sets	Completed
Birchbank, Cedarbank, Clydebank, Comliebank, Glenbank, Inverbank (six ships)	434	53.7	38	All about 5,150	Harland and Wolff, Ltd.	Bank Line (Andrew Weir and Co.)	Twin-screw, six-cylinder, single-acting, four-cycle, Harland and Wolff-B. and W. type	24 13/16	37 13/16	125	2,300	Diesel-electric engine-room auxiliaries, steam winches	Completed
Dolius	400	52.2	32	5,994	Scott's Shipbuilding and Engineering Co., Ltd.	Alfred Holt and Co.	Twin-screw, four-cylinder, double-acting, two-cycle, Scott-Still type	22	36	120	2,500	Steam and Diesel-electric auxiliaries ..	Completed
Eurymedon	425	54.5	32.7	6,223	Caledon Shipbuilding and Engineering Co., Ltd., and Burmeister and Wain	Alfred Holt and Co.	Twin-screw, eight-cylinder, four-cycle, single-acting, B. and W. type	24½	43 5/16	125	3,700	Diesel-electric, four 100 K.W. generating sets	Completed
Glenshiel	485.7	62	39.5	9,415	Harland and Wolff, Ltd.	Glen Line, Ltd.	Twin-screw, eight-cylinder, single-acting, four-cycle, Harland and Wolff-B. and W. type	29¼	45½	115	4,500	Diesel-electric, two 200 K.W., 200 r.p.m. generating sets	Completed
Iossifoglu	400.8	53.5	25.7	4,867	Swan, Hunter and Wigham Richardson, Ltd.	Ionian Marine and Land Investment Co., Ltd.	Single-screw, six-cylinder, two-cycle, single-acting Neptune type	22¼	45	100	2,000	Steam-driven engine-room and deck auxiliaries	Completed
Kistna, Kola (two ships)	278.3	40	14.2	1,538	Swan, Hunter and Wigham Richardson, Ltd.	British India Steam Navigation Co., Ltd.	Single-screw, six-cylinder, single-acting, two-cycle, Neptune type	17½	35	125	1,150	Diesel-electric, three Polar-Metropolitan-Vickers 40 K.W. generating sets	Completed
La Marea	325	48	31.75	3,682	Cammell Laird and Co., Ltd.	United Fruit Co., Ltd., of Boston	Diesel-electric propulsion. Four sets of Camellaird-Fullagar-B.T.H. generating sets	14	32	250	3,300	Diesel-electric auxiliaries, B.T.H. motor equipment and main propelling	Completed
Lochmonar .. .	485.6	62.2	35.5	9,403	Harland and Wolff, Ltd.	Royal Mail Steam Packet Co., Ltd.	Twin-screw, eight-cylinder, single-acting, four-cycle, Harland and Wolff-B. and W. type	29¼	45¼	115	4,500	Diesel-electric, four 100 K.W. 300 r.p.m. generating sets	Completed
Lubrafol	455	57.16	33.9	7,118	Sir W. G. Armstrong, Whitworth and Co., Ltd.	Société Anonyme d'Armament d'Industrie et de Commerce, Antwerp	Twin-screw, four-cylinder, two-cycle, single-acting, Armstrong-Sulzer type	23½	41½	110	2,700	Steam-driven engine-room and deck auxiliaries	Completed
Luxmi, Kathiwar (two ships)	384	48	36	4,148	Harland and Wolff, Ltd.	Andrew Weir and Co.	Single-screw, six-cylinder, single-acting, four-cycle, long-stroke, Harland and Wolff-B. and W. type	29¼	59 1/16	85	1,650	Diesel-electric, three 65 K.W. generating sets	Completed
Lycia	299.5	44.2	31	2,500	Dunlop, Bremner and Co., Ltd., and J. G. Kincaid and Co., Ltd.	T. and J. Brocklebank, Ltd. ..	Single-screw, six-cylinder, four-cycle, single-acting, long-stroke, Kincaid-B. and W. type	24 13/16	51 5/16	85	1,150	Diesel-electric and steam auxiliaries ..	Completed
Marudu	263.2	41.73	18.2	1,926	Workman, Clark and Co., Ltd., and Burmeister and Wain	Straits Steamship Co., Ltd. ..	Single-screw, six-cylinder, single-acting, long-stroke, four-cycle, Burmeister and Wain type	24½	51 5/16	110	1,500	Diesel-electric, three 100 K.W. Burmeister and Wain generating sets	Completed
Moveria	385	51.5	31	5,000	Vickers Limited	Donaldson Line, Ltd.	Single-screw, eight-cylinder, single-acting, four-cycle, Vickers solid injection type	30	45	110	2,700	Steam-driven engine-room and deck auxiliaries	Completed
Pacific Trader, Pacific Shipper (two ships)	420	57.8	30.9	6,304	William Doxford and Co., Ltd.	Furness, Withy and Co., Ltd. ..	Single-screw, four-cylinder, opposed-piston, Doxford type	22⅞	2×45½	87	2,900	Steam auxiliaries and refrigerating plant	Completed
Silurian	435	57	33.25	6,903	Blythswood Shipbuilding Co., Ltd., and William Beardmore, Ltd.	Owen and Watkin Williams, Ltd.	Twin-screw, six-cylinder, four-cycle, single-acting, Beardmore-Tosi director valve type	24 7/16	38½	126	2,800	Diesel-electric, three 80 K.W. Beardmore-Tosi-Allen generating sets	Completed
Silvercedar, Silverelm (two ships)	375	52.3	28.25	4,354	William Doxford and Co., Ltd.	Silvercedar Shipping Co., Ltd. ..	Single-screw, three-cylinder, Doxford opposed-piston type	21½	2×42½	90	1,760	Steam-driven engine-room and deck auxiliaries	Completed
Silverfir	375	52.3	28.25	4,347	William Doxford and Co., Ltd.	Mount Steamship Co., Ltd. ..	Single-screw, three-cylinder, Doxford opposed-piston type	21½	2×42½	90	1,760	Steam-driven engine-room and deck auxiliaries	Completed
Silverlarch, Silverpine (two ships)	400.3	55.3	26.3	5,122	Swan, Hunter and Wigham Richardson, Ltd.	Mount Steamship Co., Ltd. ..	Single-screw, six-cylinder, single-acting, two-cycle, Neptune type	22½	45	100	2,000	Steam-driven engine-room and deck auxiliaries	Completed
Swanley	410	55.25	29	9,300	Barclay, Curle and Co., Ltd., and North British Diesel Engine Works (1922), Ltd.	Harris and Dixon, Ltd.	Single-screw, three-cylinder, double-acting, opposed-piston, North British sliding cylinder type	24½	2×44	96	2,000	Steam-driven engine-room and deck auxiliaries	Completed
Sycamore and Tramore (two ships)	363	52	26	4,000	Furness Shipbuilding Co., Ltd., and Richardsons, Westgarth and Co., Ltd.	Furness, Withy and Co., Ltd. ..	Twin-screw, six-cylinder, four-cycle, single-acting, Richardsons-Beardmore-Tosi director valve type	24½	38½	125	2,500	Steam-driven engine-room and deck auxiliaries	Completed
Vinemoor and Westmoor (two ships)	375	52.6	25.71	4,369	William Doxford and Co., Ltd.	Moor Line, Ltd.	Single-screw, three-cylinder, opposed-piston, Doxford type	21½	2×42½	90	1,760	Steam-driven engine-room and deck auxiliaries	Completed
Wellfield	398	51.5	30.5	5,632	Tyne Iron Shipbuilding Co., Ltd., and North-Eastern Marine Engineering Co., Ltd.	Hunting and Son	Twin-screw, six-cylinder, four-cycle, single-acting, North-Eastern Werkspoor type	22 7/16	39½	125	2,200	Steam-driven auxiliaries, exhaust gas boilers	Completed

Limited, of Newcastle, which were launched during the year at the yard of Macmillan and Son, Limited, Dumbarton. Twin-screw machinery was also fitted to the Asuka Maru, particulars of which ship are given in the accompanying Table II.

John G. Kincaid and Co., Limited, of Greenock, also built the same type of engine under licence, and machinery was constructed at their works for the Brocklebank ship the Lycia. During the year several sets of Diesel-driven electric generators were built by W. H. Allen, Sons and Co., Limited, at Bedford, which firm manufactures engines of the same design for auxiliary and land purposes.

Beardmore-Tosi Type.—The four-stroke director valve type of marine engine originally designed by Tosi Brothers, of Legnano, Italy, is now built in Great Britain by William Beardmore and Co., Limited, at Dalmuir, and Richardsons, Westgarth and Co., Limited, at West Hartlepool. The Silurian, a twin-screw ship, was built at Dalmuir for Owen Watkin Williams, the Golden Cross Line, of Cardiff; and at West Hartlepool the twin-screw ships Sycamore and Tramore were completed for Furness, Withy and Co., Limited.

North-Eastern-Werkspoor Type.—At the Wallsend yard of the North-Eastern Marine Engineering Company, Limited, the tanker Wellfield with twin-screw machinery was completed, and other engines of the same type were begun. Outstanding among these marine oil engines built at Wallsend is the eight-cylinder set of 3000 indicated horse-power with 28¾in. cylinders and a stroke of 51¼in., which recently underwent successful shop trials. This machinery will be installed in the single-screw motor ship Raby Castle, owned by the Lancashire Shipping Company, Limited.

Vickers Solid Injection Type.—Three sets of oil engine machinery were completed by Vickers Limited during 1924. They include two six-cylinder 600 brake horse-power engines for Mitsubishi Shuji Kaisha, Limited, and an eight-cylinder unit with 30in. diameter cylinders and a 45in. stroke, designed for an output of 2700 brake horse-power. This engine was fitted into the 5000-ton insulated meat-carrying ship Moveria, built for the Donaldson Line, Limited. It is illustrated in Fig. 1.

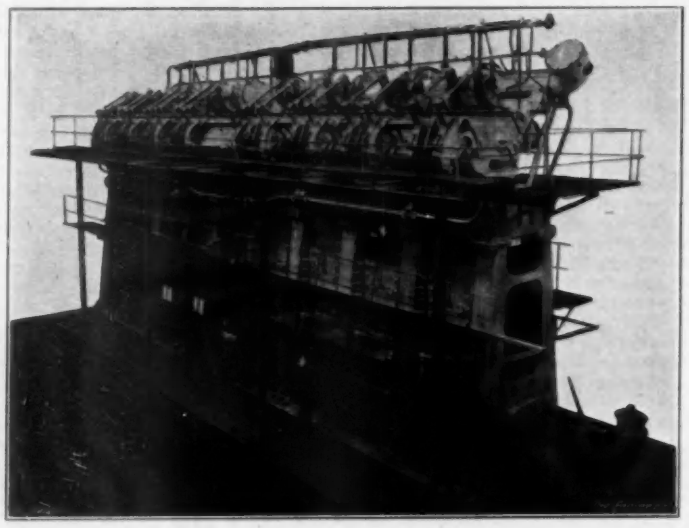


FIG. 1—8-CYLINDER 2700 B.H.P. SOLID INJECTION ENGINE—VICKERS

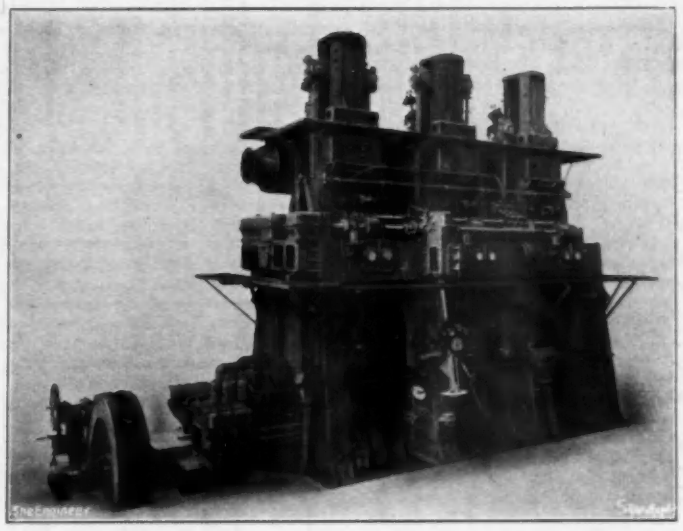


FIG. 2—NEW TYPE 3-CYLINDER 1760 B.H.P. ENGINE—DOXFORD

Two-cycle Single-acting Engines.

Sulzer Type.—It is now about thirty years since the first four-stroke Diesel engine was built, and two-stroke developments may be said to have started about ten years later. The pioneers of this type of engine were Sulzer Brothers, of Winterthur, who first introduced port scavenging, and later a simpler form of cylinder cover with many other improvements, which made this type of engine specially suitable for marine work. The Sulzer design of marine engine is now built in Great Britain by seven firms, embracing, for main propelling machinery, William Denny and Bros., Limited, Sir W. G. Armstrong, Whitworth and Co., Limited, Alex. Stephen and Sons, Limited, Fairfield Shipbuilding and Engineering Company, Limited, and John Brown and Co., Limited, whilst G. and J. Weir, Limited, build auxiliary engines of the airless injection type.

The outstanding installation of the year was undoubtedly that of the quadruple-screw motor liner Aorangi, built by the Fairfield Shipbuilding and Engineering Company, Limited, for the Union Steamship Company of New Zealand. During the past year many references were made to this liner and her engines, notably in THE ENGINEER of March 21st and June 20th, when views of two engines on test were given. In to-day's issue on page 16 we produce photographs of one of the main engines. In later issues we shall describe in detail the ship and the main and auxiliary machinery. Work was begun also at Fairfield on twin-screw, 6400 brake horse-power machinery for a cargo ship which is to be built to the order of the Houlder Line.

Another firm building Sulzer-Diesel engines is John Brown and Co., Limited, Clydebank, and during the year two sets of engines of 6000 horse-power were begun for a vessel which was built by Lithgow's Limited. On the Tyne three sets of Sulzer-Armstrong machinery were completed at Armstrong, Whitworth and Co.'s yard. They were for the locomotive-carrying ship Beldis and a Belgian tanker Lubrafol. In both ships four-cylinder engines were installed. At the works of the Wallsend Slipway and Engineering Company, Limited, another four-cylinder engine of the Wallsend-Sulzer type was completed and will be fitted in a tanker which was launched by the Furness Shipbuilding Company for owners in London. An interesting twin-screw vessel completed during the year was the Atago Maru, which was built by Lithgow's, of Port Glasgow, for the Nippon-Yusen-Kaisha. The two 2000 brake horse-power four-cylinder engines and turbo-blowers were installed by David Rowan and Co., Limited, of Glasgow.

Nobel Type.—In our early issues of 1922 particulars of the Nobel type of two-cycle engine were given, and during the year the tanker Zoroaster, completed by Götawerken with Nobel machinery, was put into commission. The engines are of the four-cylinder type and are designed for an output of 1600 brake horse-power at 105 revolutions per minute. This type of engine is all the more interesting as in Great Britain the Nobel engine is constructed by Mirrlees, Bickerton and Day, Limited, of Stockport, and a large unit is approaching completion at the firm's works at Hazel Grove, near Stockport. The firm has also granted a sub-licence for the construction of the Nobel engine to the Niigata Engineering Works, Tokio. The engines, we are informed, are to be constructed to Mirrlees' drawings based on the Nobel principle. We illustrate in Fig. 3 a four-cylinder Nobel engine with 21in. diameter cylinders and a stroke of 37½in., which was built and tested in November at Burgerhout's Engineering and Shipbuilding Company, Limited, Rotterdam. It was designed for an output of 900 brake horse-power, and successful results were obtained.

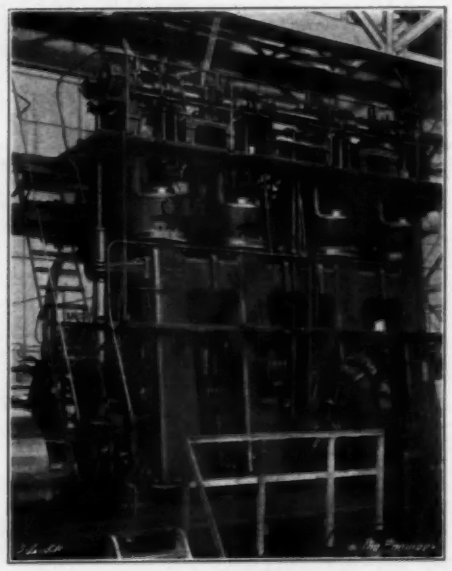


FIG. 3—900 B.H.P. BURGERHOUT-NOBEL ENGINE

Neptune Type.—During the year considerable advance was made in the Neptune type of engine built by Swan, Hunter and Wigham Richardson, Limited. Two ships, the Kola and Kistna, were completed for the British India Steam Navigation Company, Limited. They are single-screw ships with six-cylinder engines, and the cylinders have a bore of 17½in. with a stroke of 35in. Another large ship completed by the firm is the British Motorist, propelled by eight-cylinder machinery of 24in. bore and 50in. stroke. A similar set of four-cylinder 1500 B.H.P. machinery was built for the Lenfield, which, although not mentioned in Table II., ran her trials before the end of the year, and is included in the totals given in Table I. Two other ships of the year are the Silverlarch and Silverpine, with six-cylinder engines of 22½in. bore and 45in. stroke, and the motor ship Iossifoglu was also completed. Three sizes of Neptune engines are now built and serve for a wide range of ships. A feature of the new engine is the separate scavenge pump and the very much simplified form of cylinder cover and liner.

Opposed Piston Engines.

Camellaird-Fullagar Type.—During 1924 this type of engine was designed in larger sizes. The outstanding engine of the year is undoubtedly the 3000 brake horse-power Palmer-Fullagar set built for the tanker British Aviator, which vessel is illustrated in one of to-day's Supplements and was described in our issue of November 21st. This engine has six cylinders and runs at a speed of 90 revolutions per minute. The British Aviator is the highest powered single-screw motor ship at present in service, and on her trials and maiden voyage excellent results as regards fuel consumption were obtained. Messrs. Palmer's have also prepared and published a design showing an eight-cylinder engine designed to develop 10,000 shaft horse-power. Eight cylinders, each 31in. in diameter with a stroke of 48in., are proposed, there being four cylinder columns with two cylinders in each column, cross connected with rods in accordance with the usual construction. David Rowan and Co., Limited, of Glasgow, also constructed a six-cylinder set of 1600 brake horse-power machinery which was installed in the Brocklebank Line single-screw ship Baron Dalmeny.

At Birkenhead another electrically propelled fruit boat built by Cammell Laird and Co., Limited, for the United Fruit Company, of Boston, U.S.A., was placed in service. This ship is the La Marea. Her sister, the La Perla, is approaching completion. In these ships four 825 B.H.P. Camellaird-Fullagar drive four B.T.H. generating sets which supply current to the main propelling motor. The electrical equipment has, we understand, given no trouble whatsoever, but we learn that there have been certain difficulties with the engines. These the builders inform us were merely difficulties of detail such as are inherent in any new design of machinery, and there is every reason to suppose that they will be satisfactorily overcome. Apart from these defects, the engines, we are informed, have worked satisfactorily and have demonstrated their capacity to do what was expected of them.

The Doxford Engine.—At the shipyard of William Doxford and Sons, Limited, Sunderland, seven ships were completed and eight sets of machinery were built. Two single-screw ships are the Pacific Shipper and the Pacific Trader, 420ft. vessels, built for Furness, Withy and Co., in which four-cylinder engines are installed. During the year a new type of three-cylinder engine was designed and built. In it are embodied new features which include a simplified form of main column and a different cam shaft and scavenge pump drive, which gives a shorter engine. Four such engines—see Fig. 2—were built and fitted in single-

screw ships, two such in the Silverelm and Silvercedar, built for the Silvercedar Shipping Company, Limited; another vessel, the Silverfir, was completed for the St. Helens Steamship Company, Limited. Two other ships for the Moor Line, the Vinemoor and Westmoor, were finished, whilst four-cylinder engines of the same design were built and tested for the Port Hobart, a vessel which will shortly be completed for the Commonwealth Dominion Line, Limited. An outstanding feature of this design is the low fuel consumption, which reaches the remarkable figure of 0.35 lb. per brake horse-power at full load. This result was obtained on engines for the Silverelm using 0.89 sp. gr. Anglo-Diesel oil. With the four-cylinder type of engine a fuel consumption of 0.37 lb. of oil per brake horse-power was obtained.

Scott-Still Type.—One of the most interesting ships of the year was the motor ship Dolius—see one of our Supplements to-day—built for the Blue Funnel Line of Alfred Holt and Co., Limited, by Scott's Shipbuilding and Engineering Company, Limited, of Greenock. This engine was illustrated and described in THE ENGINEER, and in our issue of April 2nd, 1924, a full description of the ship was given. On June 6th we published particulars of her very satisfactory performance during her maiden voyage to Algiers. Her owners inform us, however, that her subsequent voyage to Java was less satisfactory. The constant pressure oil system which operated the steam valves gave trouble through aeration of the oil in the system. As a result the steam cooling of the pistons, particularly in the third starboard low-pressure cylinder, was affected, with the result that the piston skirt distorted, rubbed the walls, and cracked that cylinder liner. Messrs. Scott's carried out several improvements on the machinery mainly in the direction of simplification, and the vessel left the Clyde for Japan at the end of the year. On December 3rd a trial was run to and from Arran, and the excellent results obtained in the first trials of the Dolius were again reproduced. Messrs. Scott's have a further order in hand for another ship of the same type for the same owners.

Double-acting Engines.

The year 1924 may be singled out for the progress which was made in the design and production of double-acting engines. In our issues of April 23rd and May 2nd a description of the North British sliding cylinder type of two-stroke, double-acting engine was published, and on July 11th particulars of the motor ship Swanley were given. The ship was built by Barclay, Curle and Co., Limited, for Harris and Dixon, Limited, of London, and was the first vessel to be fitted with machinery of that type. An illustration of the Swanley is reproduced in one of to-day's Supplements. During several long voyages the engine worked very satisfactorily and improvements were made in small details, but no alterations to the principal parts were found necessary.

Last year we published an account of the four-stroke, double-acting, experimental engine built by Burmeister and Wain, Limited. Much activity at Copenhagen and Belfast centred around the construction of machinery of this type during the year. At Copenhagen one engine for the Swedish-America 17,000-ton liner Gripsholm was built and the other is well advanced. They are six-cylinder units with a bore of 33in. and a 59in. stroke, and are designed for a total output of 13,500 shaft horse-power. The ship was launched by Sir W. G. Armstrong, Whitworth and Co., Limited, in the autumn. The same type of engine will be used in several ships which were started at Harland and Wolff's Belfast yards during the year, and good progress was made with both machinery and hull. The ships referred to include three large passenger motor liners for the Royal Mail and Union-Castle lines, with engines of 20,000 indicated horse-power on two screws, and during the year the firm received two further orders for motor passenger liners for the British and African Steam Navigation Company, Limited.

Another four-stroke double-acting motor of interesting design was that built jointly by the North-Eastern Marine Engineering Company, Limited, Wallsend, and Werkspoor, Amsterdam, and tested at Wallsend. The engine referred to was described in THE ENGINEER of May 30th and June 6th, while trial results were given in the issue following. Very favourable comment followed the trials, and some multi-cylinder engines of the same type were ordered during the year, both at Wallsend and Amsterdam. Experimental work on a two-cycle design will shortly be begun at Amsterdam.

Turning to two-stroke double-acting engines, we may mention the American Worthington design. The results of the tests on an experimental single-cylinder engine were given in THE ENGINEER of October 3rd, when illustrations of the engine were reproduced. The rights of the Worthington engine for Great Britain and the British Empire are vested with the Worthington-Simpson Company, of Queen's House, Kingsway, London, which company has its works at Newark, and is in negotiation with shipbuilders regarding licences. Another prominent engine of the same type is the M.A.N. two-cycle, double-acting engine which was tested during the year at Augsburg, and for which licences have been granted in Germany and America. It is equally certain that this type of prime mover will be constructed in England, although at present negotiations are not far enough advanced to enable us to give the names of firms interested.

Auxiliary Machinery.

Electrically-driven auxiliaries found increased use, both for engine-room and deck use, not only in motor ships, but also in steam turbine propelled vessels. We noted during the past year a tendency towards the use of reduced running speeds for Diesel-electric generators. Another feature of recent practice was the introduction of the airless injection type of oil engine for auxiliary and emergency use. Units of this type were supplied by Sulzer Bros. and G. and J. Weir, Limited, which latter firm builds the Sulzer type of engine under licence. In other ships a new type of Polar oil engine with mechanical fuel injection was employed. A description of this engine was given in THE ENGINEER of December 5th. On vessels equipped with two-stroke propelling machinery increased use is now made of turbo-blowers, electrically driven at high speeds up to 3000 revolutions per minute. The larger number of such blowers fitted during the year are of the Brown-Boveri type, and we note with interest that in the future this type of blower will be manufactured on the Clyde by James Howden and Co., Limited. Other machines were constructed by Reavell and Co., of Ipswich. One such blower is steam turbine driven, and for motor ships which were laid down towards the end of the year there was a marked increase in the number of steam turbine driven scavenging blowers. Steam turbines for this purpose were supplied by W. H. Allen, Sons and Co., Limited, of Bedford, and the British Thomson-Houston Company, Limited, of Rugby. In several ships equipped with steam auxiliaries use is made of the exhaust gases for steam raising and feed heating. In spite of the economy of the all-electric ship, steam auxiliaries comprising standard steering gear and winches continued to be used in a large measure. On the other hand, there is no lack of well-designed electrically operated steering gears, such as those supplied by Brown Bros., of Edinburgh, and Donkin, of Newcastle, which firm is associated with Laurence Scott, Limited, of Norwich, in the construction of such machinery. Standard type electric winches were also supplied by the Norwich firm and by Clarke, Chapman and Co., Limited, of Newcastle.

Diesel Engine Research and Testing Work.

A notable contribution to the literature of oil engine research was the paper given by Engineer-Commander Beeman before the Institution of Naval Architects and reprinted in THE ENGINEER of May 2nd and the three subsequent issues. Although that paper deals mainly with experiments made at the Admiralty Engineering Laboratory at West Drayton, the data given are such as to be of considerable value to commercial and marine builders of oil engines. In June last it was announced by Mr. D. B. Morison that Richardsons, Westgarth and Co., Limited, in association with Messrs. Tosi Bros., Beardmore, and Furness, Withy, would undertake exhaustive tests of one or more types of marine oil engines, including a double-acting type. Sir George Goodwin is actively connected with this work. Just before the close of the year the first report of the Marine Oil Engine Trials Committee was published. It dealt with the tests made on the motor ship Sycamore, which was equipped with oil engines of the Richardsons-Beardmore-Tosi type, and a *résumé* of the report was given in THE ENGINEER of November 28th. An arresting feature of this report is the apparent serious discrepancy between the torque measured by torsion meter at the propeller shaft and that calculated from the known indicated horse-power and mechanical efficiency of the engine. The hope may be expressed that the Committee will deal fully with the running costs, and machinery weights of the different types of engine tested. In this respect much may be learned from similar work for the land type of engine which was well and usefully done by the Diesel Engine Users' Association, which body, we remember, is represented on the Marine Trials Committee.

The question of the metallurgy of cast iron used for oil engine cylinder covers, liners, valves, and fuel pump parts has always been a most important one. In this connection we would mention a joint meeting held at Glasgow by the Scottish Section of the Institution of Mechanical Engineers and the Scottish Section of the Association of British Foundrymen to discuss the question of castings for marine engines. The free exchange of opinion between the designer and the foundryman which took place could not but benefit considerably the object for which that meeting was called. Apart from the work of moulding, attention was drawn to problems of the smelting of cast iron. There is little doubt that some of the best Diesel castings are those produced from the electric furnace or from an open-hearth furnace of the Siemens type.

Progress in America and on the Continent.

During the past year interest in American shipbuilding and marine oil engine circles was chiefly centred around the question of converting the steamers owned by the United States Shipping Board into motor ships, with a view to enabling them to replace less economical coal-burning and oil-burning vessels. Such conversions have already been made, and the Challenger, a single-screw, 11,850-ton deadweight steamer, completed during the year, was the third ship to be fitted with a Sun-Doxford four-cylinder engine built by the Sun Shipbuilding Company, of Chester, Pa. In December the decision of the Shipping Board with regard to converting eighteen ships was made known, and particulars of the orders placed for the main engines were given. In the single-acting type of engine, both four-stroke and two-stroke engines were represented by thirteen installations, while five double-acting engines (four two-stroke and one four stroke) were ordered. In no case did the output of the engines offered exceed 3050 shaft horse-power. Cramps, of Philadelphia, put forward the Burmeister and Wain type of single-acting engine, whilst the McIntosh and Seymour Corporation and the Pacific Diesel Engine Company also favoured the four-stroke engine. The two-cycle type of single-acting engine was represented by the Busch-Sulzer Company.

Turning to double-acting engines, two units of 2900 shaft horse-power were ordered from the Worthington Pump Corporation, whilst another two-stroke double-acting engine will be built to M.A.N. designs by the Hooven, Owens and Rentschler Company. The New London Ship and Engineering Company is also to build a 3000 shaft horse-power M.A.N. type engine, whilst the McIntosh and Seymour Corporation will construct a four-stroke double-acting engine of 2700 shaft horse-power. The average price for the single-acting engines came out at about £18 per shaft horse-power, whereas the same figure for the five double-acting engines was in the neighbourhood of £16 5s.

During the year the Bethlehem Company built a new type of two-stroke engine, with six cylinders, 25½in. bore and 48in. stroke, designed to develop 2400 shaft horse-power at 100 revolutions per minute. This unit was installed in the Cubore, a 468ft. ship, which was built in 1920. Some ships for American lines were constructed by Swedish builders, and two of such were the City of San Francisco and the City of Panama, 3000-ton passenger and cargo vessels, built for the Pacific Coast service.

In Germany considerable progress was made and a large number of motor ships were laid down. German geared motor ships showed good running results. This form of gearing and also the Föttinger hydraulic coupling were described in papers read before the German Institution of Naval Architects by Dr. Fram and Dr. Bauer. A summary of these papers was given in THE ENGINEER of December 5th. The Hamburg–South American liner Monte Sarmiento was a fine example of a geared ship. She is engined with four six-cylinder 1750 brake horse-power sets, running at 215 revolutions per minute, with a propeller speed of 77 revolutions. Great interest centred around the experimental 1100 brake horse-power, two-stroke, double-acting engine designed and tested at Augsburg by the M.A.N. Company, and a 15,000 horse-power unit of this type was begun by Blohm and Voss, Hamburg, for the Hamburg electricity works.

Another notable advance was the introduction of supercharging for four-stroke engines. By increasing the compression of the air admitted to the cylinders, the power of a given unit was found by experiment to be increased by about 20 per cent. Superchargers will be fitted to German, Swedish and Danish-built ships.

In Denmark Burmeister and Wain completed seven ships and a floating dock for use in the company's yard. The aggregate gross tonnage was over 27,000 tons, and the machinery totalled over 14,000 indicated horse-power. Götawerken, of Gothenburg, Sweden, completed five large vessels of 21,450 gross tons total, with machinery of 14,400 indicated horse-power. The same company had on hand at the end of the year twelve vessels aggregating over 60,000 tons, and oil engine machinery of 17,400 horse-power.

In Holland progress was made with the Werkspoor double-acting four-stroke engine, and Burgerhouts built the Nobel engine we illustrate to-day. At Winterthur, Switzerland, Sulzer Bros. completed fifty-two two-cycle marine engines, aggregating 19,500 total indicated horse-power. Sulzer-engined vessels were also completed by the Rotterdam Dry Dock Company's and the "De Schelde" yards. The year, as regards France, held little of note. One motor ship, built for the Chargeurs Réunis, of Paris, by the Ateliers et Chantiers de la Loire at Nantes, and fitted with Sulzer engines, was placed in commission.

Italian motor ships included one tanker, engined with Ansaldo San Giorgo machinery, and one ship built by Ansaldo with Sulzer engines, but next year will see several Italian motor ships of an unusually interesting type begun. They will include two passenger liners with twin-screw machinery of about 20,000 shaft horse-power total, and will be built at the Monfalcone yards, near Triestino, for the Cosulich Lines.

Small Motor Craft.

Firms building small motor craft were busy during the year. J. W. Brooke and Co., Limited, of Lowestoft, built a large number of the firm's well-known Empire type of engine, and racing engines, whilst the Ailsa

Craig Motor Company, Limited, of Strand-on-the-Green, Chiswick, had considerable success with the Kid engine, which is now built in several sizes.

In our issue of December 26th a description of the Vaila, a fast motor cruiser, built to the special designs of Norman Hart, for the Scottish Fishery Board, was given. The vessel is of a new type, in which the advantages of a stepless hydroplane hull are combined with the weight and draught of a displacement type of hull. The Vaila was built by Hugh McLean and Sons, of Govan, Glasgow, and engined by Gleniffer Motors, Limited, of Anniesland, Glasgow.

During the year John I. Thornycroft and Co., Limited, completed several motor boats, and supplied marine motors aggregating 10.000 brake horse-power. An interesting feature of the firm's development work was the construction of a new type of Thornycroft-Record engine, which will be shortly tested.

Conclusion.

From the necessarily brief review of the year's progress which we give, it will be appreciated that the British marine oil engine industry in 1924, despite the lack of new orders, was characterised by energy and initiative in all its many branches. If the industry continues to receive the support of the shipowner, both British and foreign, which it deserves, we see no reason why this, the most notable development of modern marine engineering, should not hold a more than hopeful future.

Naval Construction in 1924.

IN spite of the criticisms which have been directed against the Washington Naval Treaty, notably in the country of its origin, there is no denying its effectiveness as a restraint upon heavy naval construction. Three years ago, when the Treaty was under negotiation, capital ships to the number of thirty-four were building or on order for the three principal navies, viz., fifteen for the United States, fifteen for Japan, and four for Great Britain. As these vessels averaged at least 42,000 tons in displacement, they represented a total of about 1,428,000 tons. Moreover, the four British ships were but the first instalment of a programme which aimed at rebuilding the Fleet on a post-Jutland basis. It is certain therefore that but for the Treaty there would now have been many more capital ships on the stocks in this country. As it is, the only such vessels under construction anywhere in the world to-day are two battleships for the British Navy, aggregating 70,000 tons. The contrast between this figure and that of December, 1921, affords striking proof of the efficacy of the Treaty as a curb on battleship construction. In all other classes of naval tonnage the past year witnessed a marked revival of building activity. After a pause of six years, we laid down a batch of cruisers which are intended to replace the obsolete "County" class, long since scrapped. We also resumed the building of destroyers and submarines, albeit on a very moderate scale. Excepting a few submarines, the United States has no new construction in hand, nor is it probable that the eight 10,000-ton cruisers voted by Congress last month will be begun before 1926. Japan is working steadily on her programme of light construction; France laid the keels of several ships authorised under the second half of the 1922 Navy Law; and Italy ordered two cruisers, besides many smaller craft. Most of the secondary naval Powers are building ships of a type suited to their financial resources. Consequently, the number of new naval vessels in hand is fairly large, though their aggregate displacement may not seem imposing.

British Empire.

Full details of the battleships Nelson and Rodney, which were begun in December, 1922, have not yet been disclosed, but the leading dimensions are officially announced as follows:—Length on water-line, 702ft.; maximum breadth, 106ft.; mean draught, 30ft.; standard displacement, 35,000 tons.* Various periodicals gave the main armament as nine 16in. guns in triple turrets, but this figure has still to be confirmed. In the course of a discussion at the Institution of Naval Architects in April, Sir Philip Watts said that he understood the ships would not have bulges. The above dimensions show the "Nelson" class to be some 60ft. longer and 15½ft. broader than the "Queen Elizabeths"; while compared with the "Royal Sovereigns," the vessels will be 82ft. longer and 3½ft. more in beam. It is clear that no very high speed is aimed at, and that the underwater protection is extensive. If carried in triple barbettes, nine 16in. guns would weigh scarcely more than eight similar guns twin-mounted, of which the weight complete would be 7100 tons. Such a main armament would account for 20.3 per cent. of the displacement in a 35,000-ton ship, a higher precentage than obtains n any previous British battleship of modern type.

* "Standard displacement" is defined in the Washington Treaty as "the displacement of the ship complete, fully manned, engined and equipped ready for sea, including all armament and ammunition, equipment, outfit, provisions and fresh water for crew, miscellaneous stores and implements of every description that are intended to be carried in war, but without fuel or reserve feed water on board."

In the Hood this item preëmpts 12.5 per cent., in the Queen Elizabeth 16.5 per cent., and in the Iron Duke and the Royal Sovereign 18 per cent. The appearance of triple barbettes in the "Nelson" class would occasion no surprise, for that system of mounting has advantages which balance, if they do not outweigh, the drawbacks. It enables more guns to be carried for a given weight, including protection; it economises space and tends to facilitate fire control. As the new ships will be the first in our Navy to incorporate fully the lessons of Jutland, they are doubtless to be of massive construction and to carry a great deal of armour. Their powers of resistance to all forms of attack will probably surpass those of any earlier ship, British or foreign. The construction of the Nelson by Sir W. G. Armstrong, Whitworth and Co., and of the Rodney by Cammell Laird and Co., was seriously delayed by the boilermakers' lock-out in 1923, and although laid down two years ago, neither is yet ready for launching. It is doubtful whether they will enter service before the end of 1926. No further capital ships may then be laid down until 1931, in which year the Treaty entitles us to begin two.

When the Labour Government assumed office in January of last year, it struck out thirteen ships from the programme introduced by the preceding administration, which had comprised twenty vessels. This left only five cruisers and two destroyers, all of which are now in hand. Of the cruisers, the Cornwall was laid down at Devonport on October 9th; the Suffolk at Portsmouth on September 30th; the Kent at Chatham on November 15th; the Cumberland by Vickers Limited at Barrow, in October; and the Berwick by the Fairfield Company, at Govan, in November. The machinery for the three dockyard-built ships is to be supplied respectively by the Parsons Marine Steam Turbine Company, R. and W. Hawthorn, Leslie and Co., and W. Beardmore and Co. Beyond the fact that they will displace 10,000 tons and carry 8in. guns, little of an authentic nature is known about these cruisers. The Director of Naval Construction has intimated, however, that the design does not provide for the stowage of aeroplanes.

On June 18th there was launched at Devonport the cruiser-minelayer Adventure, which had been laid down under the 1921–22 Estimates on November 29th, 1922. Her leading dimensions are:—Length between perpendiculars, 500ft.; overall, 520ft.; breadth, 58ft.; mean draught, 19¼ft.; displacement 7260 tons. It is reported in "Jane's Fighting Ships" that she will be propelled by Parsons turbines, with Diesel engines for cruising purposes. An official drawing published at the launch shows the ship to have a flush-decked hull with high freeboard, two funnels, and a tripod foremast. Further details must be withheld for the present.

With the commissioning of the Frobisher in the autumn, there now remain but two uncompleted cruisers of the war programme, viz., Emerald and Enterprise. The former, which is being fitted out at Chatham, is due to hoist the pennant in July of this year, while the Enterprise will not be ready until the following December. As both were laid down in the summer of 1918, they have been an unconscionable time a-building. They are of interest as typifying the first British light cruisers of really high speed, and are expected to attain 33 knots in light condition. Length overall, 570ft.; breadth, 54½ft.; mean draught, 16½ft.; displacement, 7600 tons. Machinery: four sets of Brown-Curtis turbines with gearing, eight Yarrow small-tube boilers fired with oil, four propellers, 80,000 shaft horse-power. Armament: seven 6in. guns, two 4in. A.A. guns, twelve torpedo tubes.

Two destroyers provided under the current Estimates were ordered in July, the Ambuscade from Yarrow and Co., Limited, the Amazon from J. I. Thornycroft and Co., Limited. They are understood to be of an experimental type, embodying many novel and important features. It is considered probable that the vessels dropped last year by the Labour Government will be reinstated in the forthcoming Estimates. They were—three 10,000-ton cruisers, three submarines, two gunboats, an aircraft carrier, a minelayer, a special ship for the Persian Gulf, a destroyer depôt ship, and a submarine depôt ship. If the Admiralty's schedule for the replacement of obsolete material is to be adhered to, at least six cruisers should be authorised this year.

Late in November the Australian Government invited eleven British firms to tender for two cruisers of 10,000 tons, the orders for which will soon be placed. The ships are understood to be uniform in design with the five "County" cruisers now being built for the Royal Navy. Australia has also invited tenders in Great Britain for two submarines with a cruising radius of 3000 miles. The Sydney correspondent of *The Times* reported on October 28th that no opportunity would be given for the construction of these vessels in Australia, as the work was considered to be of too specialised a nature, and "because it is doubtful whether, in view of the secrecy of the specifications, the Admiralty would agree to Australian construction."

On December 31st, 1923, Sir Eustace T. d'Eyncourt relinquished the post of Director of Naval Construction, which he had held for upwards of eleven years. We take this opportunity of offering our tribute to the invaluable services which he rendered the country. He was responsible for the design of all our fighting ships built during the war, among which are numbered such remarkable vessels as the two "Renowns," the Hood, the aircraft carriers Eagle and Hermes, and the "K" and "M" class submarines. During his tenure of office changes of a drastic character took place in the design of every type of ship, and if Great Britain still maintains her lead in the science of naval construction, the major share of the credit belongs to the late Director. Amidst his arduous labours for the Navy he found time to take a prominent part in developing tanks for field warfare. In appointing his successor the Admiralty made a departure from precedent by selecting a member of the Royal Corps of Naval Constructors, instead of an official of one of the great private yards, as was done on the previous three occasions. Mr. W. J. Berry, C.B., the new Director of Naval Construction, has had a distinguished career, and his appointment is a well-deserved compliment to the Royal Corps as a whole.

United States.

During the past year the battleship West Virginia was placed in commission. She is the third and last unit of the "Maryland" class, which has been fully described in our columns—see THE ENGINEER, January 25th, 1924. No further capital ships may be built for the United States Navy until 1931. All the ten scout cruisers of the "Omaha" class, laid down in 1918–20, are now finished, or practically so. They have proved quite successful, most of them having exceeded the contract speed of 33.7 knots; nor have "shaking-down" cruises of many thousands of miles revealed any shortcomings in structure or machinery. This type, it may be recalled, has a displacement of 7500 tons, turbines with reduction gearing to develop 90,000 shaft horse-power, and a main battery of twelve 6in. guns. The Raleigh of this class, built by the Fore River Company at Quincy, Mass., was commissioned on February 6th. She is equipped with twelve oil-fired Yarrow boilers with a working pressure of 265 lb. On a four-hour trial at full power, of which the main data are given below, she achieved a mean speed of 34.6 knots:—

Revolutions per minute	382.64
Speed, in knots	34.63
Displacement, tons	7197.9
Shaft horse-power	97,722
Boiler heating surface, square feet	90,984
Oil consumption per hour, lb.	91,485

The displacement on this trial run, it will be noted, was some 300 tons below the normal figure of 7500 tons. A sister ship, Milwaukee, also fitted with Yarrow boilers, maintained an average of 90,060 shaft horse-power and 34.7 knots on her four-hour run at full power. The speed record for the class is understood to be held by the Detroit, with 97,375 shaft horse-power and 35.05 knots.

During the summer the submarine V 1 was launched at Portsmouth, N.H., and made her first trial trip on November 18th. This boat, the largest so far built for the United States Navy, is one of a group of three "fleet submarines" designed to accompany the fleet in all weathers, and is therefore endowed with high speed, good sea-keeping qualities, and a wide radius of action. Dimensions, &c.:—Length, 341ft.; beam, 27½ft.; displacement on surface, 2164 tons; speeds, 21 knots above and 9 knots below water; armament, one 5in. and one 3in. guns on high-angle mountings, six torpedo tubes; complement, 87 officers and men. The V 2 and V 3 of the same class are also building at Portsmouth, N.H. A new minelaying submarine was authorised on May 28th. She is to be of high speed and large cruising radius, and the cost is not to exceed 5,300,000 dollars for hull and machinery and 850,000 dollars for armour and armament. The boat is one of nine fleet submarines of the 1916 programme, of which three—viz., V 1, V 2, and V 3—were authorised several years ago, this being the fourth unit of the series. Funds have still to be voted for laying down the other five boats. Eight 10,000-ton cruisers and several gunboats for the Chinese river patrol are included in the programme sanctioned in December, 1924, but the opening of credits for their construction is deferred. Work is proceeding very slowly on the aircraft carriers Lexington and Saratoga. Converted from battle-cruisers, these ships will displace 33,000 tons and mount eight 8in. guns apiece, by far the heaviest armament projected for any aircraft carriers up to now. The speed is to be 33.25 knots. They will so far resemble H.M.S. Eagle and Hermes as to have funnel and superstructure placed on the extreme starboard side, thus leaving most of the flight deck unobstructed. The fleet repair ship Medusa was completed at Puget Sound Dockyard in July. She is 485ft. in length, displaces 9960 tons, steams at 16 knots, and is extensively equipped with plant for all heavy and light repairs that can be undertaken without recourse to a dockyard.

In his statement to Congress last month the Secretary of the Navy denied that the service was suffering from the deficiencies attributed to it by certain American critics, or that the Treaty ratio of strength had been allowed to lapse. He disclaimed all sympathy with the legend that the United States was "outgeneralled" at the Washington Conference, adding:—"The fact is, we got exactly what we proposed, and I am perfectly willing to accept the judgment of those who participated in the Treaty that our battleship

strength at the conclusion of scrapping was substantially in the ratio stated."

Japan.

No capital ship is under construction for the Japanese Navy, nor can any vessel of this type be laid down before 1931. The most important ships to be completed during the year were the light cruisers Jintsuu and Sendai, both of which were commissioned in April. They belong to the "Kuma-Natori" class, of which fourteen have been built in all. The displacement is 5500 to 5570 tons, the speed 33 knots, and the main battery seven 5.5in. guns. Although these ships are excellent specimens of the small cruiser type, combining high speed with good sea-keeping attributes, their tactical value under present and future conditions cannot be placed very high, and it is rather curious that so many of them should have been built. In fighting power they are completely outclassed by the big cruisers of the 10,000-ton class, which the Washington Treaty may be said to have standardised for all important navies. The Kinu, an earlier unit of the "Kuma" group, had to be withdrawn from active service during the summer on account of machinery troubles. Four other cruisers are now under construction in private yards: the Kako, Furutaka, Kinugasa, and Aoba. They will displace 7100 tons and have a speed of 33 knots. The armament has been officially returned as six 8in. guns, but the substitution of a battery of 6in. weapons is considered probable. A still more powerful design is represented by the Nachi and the Myoko, the first of which was laid down at Kure in February and the second at Yokosuka on October 25th. Their displacement is 10,000 tons and they will mount eight or twelve 8in. guns. Two sister ships are to be laid down next year. Other important vessels in hand are the aircraft carriers Akagi and Kaga. The Akagi, originally a battle-cruiser, is to displace 33,000 tons and have a speed of 33 knots; while the Kaga, which was begun as a battleship, is to be of 27,000 tons and 23 knots. From ten to fifteen destroyers are in various stages of construction. The following are the dates on which destroyers of the first class were completed:—No. 1, December 28th, 1922; No. 3, June 16th, 1923; No. 5, May 31st, 1923; No. 7, April 5th, 1924. Nos. 21 and 23 were laid down in March, 1924. All these boats are of 1420 tons, with a speed of 34.5 knots. Twenty-four submarines are building or projected. No. 44, a boat of 1400 tons, began its trials last February; No. 72 was delivered in the preceding month; No. 84 was launched at the Kawasaki Yard, Kobe, on January 24th; and No. 54 was laid down at Sasebo on November 24th. Few details of Japanese submarines are published, but with reference to recent statements that very large submersible cruisers designed on the Flamm principle of stability are being built for the Japanese Government, we are informed by Professor Oswald Flamm that he has not, so far, disposed of any of his patents in Japan. The submarine depôt ship Chogei was launched at the Mitsubishi Yard, Nagasaki, on March 24th. This vessel is 380ft. in length, 53½ft. in breadth, and displaces 8500 tons. She will have turbine engines driving twin screws, five boilers, and is to be armed with four 5.5in. guns. The Jingei, a sister ship, was completed in the summer.

France.

An analysis of the French building programme was published in THE ENGINEER of November 21st, 1924. At the present date there are under construction five cruisers, six flotilla leaders, eighteen destroyers, and twenty-three submarines, a larger volume of new tonnage than any other country, with the possible exception of Japan, can show. There remain to be laid down four cruisers, fifteen flotilla leaders, eighteen destroyers and twenty-eight submarines. The light cruiser Duguay-Trouin, which went afloat at Brest in August, 1923, should now be ready for her trials; the Lamotte-Picquet was launched at Lorient on March 21st, 1924, and the Primauguet at Brest on May 21st. The design of these three sister ships has not escaped criticism in France. Their leading particulars are as follows:—Length overall, 604ft.; breadth, 56½ft.; draught, 17½ft.; normal displacement, 7880 tons. Machinery, four sets of Parsons geared turbines developing 100,000 horse-power through four shafts, for a speed of 34.5 knots, and taking steam from eight Guyot boilers. Armament, eight 6.1in. 55-calibre guns in four turrets on the centre line; four 2.9in. A.A. guns; twelve 21.7in. torpedo tubes. There is no armour on the sides, the only protection to vitals being afforded by a thin steel deck amidships. The barbettes have hoods just sufficiently thick to deflect splinters, and the conning tower is similarly defended. For all practical purposes the ships are denuded of armour. Though the 6.1in. guns are a new model of extraordinarily high velocity, the armament is very light for ships of this tonnage, and it looks as though an exorbitant price had been paid to secure the speed aimed at. One meritorious feature of the design is the provision of two aeroplanes with catapult launching gear. In the succeeding class, of which the Tourville is the name ship, the displacement has been raised and the armament increased, while the speed is 1½ knots less; but again no attempt has been made to fit shell-proof armour. The Tourville was laid down at Lorient in July, the Duquesne at Brest in August, and four more ships of the same class are to be completed before the end of 1931. Principal dimensions, &c.:—Length, 607ft.; breadth, 62.3ft.; draught, 19.7ft.; displacement, 10,000 tons. Machinery, four sets of Parsons geared turbines developing 130,000 shaft horse-power for 33 knots. Armament, eight 8in. guns in four barbettes; eight 2.9in. A.A. guns, six torpedo tubes. Complement, 600 officers and men. Stowage and launching gear for four aeroplanes is provided.

All the six flotilla leaders of the "Jaguar" class are now afloat and well advanced towards completion. They are among, if not actually, the heaviest vessels of the destroyer class in existence, displacing 2362 tons normally and 2700 tons at full load. They approximate to scout cruisers, not merely in size, but in armament and cruising endurance. Five 5.1in. guns are mounted singly on the centre line, the original battery of six guns, partly on twin mountings, having been modified for the sake of stability. There are also two 2.9in. A.A. guns and six 21.7in. torpedo tubes. Designed for a maximum speed of 35.5 knots, they carry enough oil for a voyage of 2500 miles at 18 knots. In smooth water these ships should make short work of the average destroyer, but it is to be feared that their heavy deck load will make them indifferent sea boats. The eighteen smaller destroyers now on the stocks are of 1430 tons and 33 knots speed, mounting four 5.1in. guns, one 2.9in. A.A. gun, and six tubes. They will have a radius of 3000 miles at 15 knots. The two largest submarines in hand are the Redoubtable and Vengeur, displacing 2400 tons above and 3000 tons below water, with a surface speed of 18 knots. Next in order of size come the nine "Requin" boats, of 1130 tons surface displacement and 16 knots speed, with a radius of 7000 miles at 9 knots, and a battery of eight 21.7in. torpedo tubes, besides a 3.9in. gun. The twelve smaller "Ariane" boats vary slightly in dimensions, but average 595 tons. Their surface speed is 14 knots, radius 2000 miles at 10 knots, and armament seven tubes and one 3.9in. gun. All the foregoing submarines are either on the stocks or already in the water, and as the slips are vacated additional boats will be laid down.

Italy.

Italian naval construction was reviewed so lately in these pages* that it will suffice to repeat the main facts. Two cruisers were laid down some months ago, the Trento at Leghorn and the Trieste at the port of that name. The displacement is 10,000 tons, speed 35 knots, and principal armament eight 8in. guns. Other vessels begun during the year were eight destroyers and eight submarines. A small minelayer, the Fasana, was launched on September 24th. From 1925 to 1927, inclusive, it is proposed to build each year four destroyers and four submarines. Further, two new cruisers will be begun in the current year and a fifth in 1927.

Spain.

Satisfactory progress is being made with the Spanish shipbuilding programme. The cruiser Principe Alfonso was launched at Ferrol in June, and a sister ship, Almirante Cervera, is to take the water this year. Of British design, these ships are very similar to our "E" class cruisers, differing mainly in the strength and disposition of their armament. Leading particulars:—Length overall, 579ft.; breadth, 53ft.; draught, 16½ft.; displacement, 7850 tons. Machinery, Parsons geared turbines, ten Yarrow boilers, 80,000 shaft horse-power = 33 knots. Eight 6in. guns, four 4in. A.A., and twelve torpedo tubes comprise the armament. These ships complete the Spanish cruiser programme authorised in 1915. Two smaller cruisers, Don Blas de Lezo and Mendez Nuñez, also built at Ferrol, were put into service during the past year. They are of 4725 tons displacement and have Parsons geared turbines of 45,000 shaft horse-power for a speed of 29 knots. The boilers are arranged for coal and oil fuel. On her trials in July the Mendez Nuñez proved herself a most efficient steamer. During an eight-hour run a mean of 38,500 shaft horse-power was maintained, this being equivalent to 28 knots. A four-hour run at full power resulted in a mean of 44,987 shaft horse-power, and a speed of 29.050 knots. Three destroyers of the "Alsedo" class were delivered by the Cartagena yard in the course of the year. Nominally 34-knot boats, the Alsedo and the Velasco are reported to have attained 37 knots on trial. Three large flotilla leaders are in hand, the Churruca having been launched recently, while the Galiano was half finished in October. The third vessel, Barcairtegui, is less advanced. They are vessels of 1650 tons, with a speed of 36 knots. Of the six 900-ton submarines building for the Spanish Navy, the C 1, C 2, and C 3 are near completion; C 4 was laid down in January last, and the other two are also believed to be on the stocks.

Netherlands.

The new Dutch cruisers Java and Sumatra were described and illustrated in this journal on November 7th, 1924. Two gunboats destined for the East Indies Marine are being built. They will displace 1676 tons, have a speed of 15 knots, and be armed with three 5.9in. guns and one 3in. A.A. piece. Contracts for two destroyers, also for the East Indies, will shortly be placed. They will be built in Holland under the supervision of Yarrow and Co., Limited, who are supplying the designs and complete technical information. This order was booked by Yarrow and Co., Limited, in competition with many other destroyer builders, including firms in France, Germany, and the United States. The boats will be 321½ft. in length, 31ft. in breadth, and displace 1620 tons. They are to have machinery of 31,000 shaft horse-power for a speed of 34 knots. Armament, four 4.7in. guns, two 3in. A.A. guns, six 21in. torpedo tubes.

Minor Navies.

The German cruiser laid down at Wilhelmshaven two years ago will be launched early this year. Her construction has been delayed by a shortage of skilled shipwrights. She is 6000 tons in displacement and is expected to reach the speed of 29 knots. The armament is nine or ten 5.9in. guns mounted on the centre line. This ship has a high freeboard and will be fitted with a tripod foremast. Funds for a destroyer were voted by the Reichstag last year, but the boat has not yet been laid down.

Norway has two small Holland-type submarines in hand. The Swedish Government ordered in October two destroyers of 974 tons and 35 knots. Denmark has begun two submarines. Russia is believed to be working on a certain amount of new construction, including cruisers and destroyers, but naval information from this source is contradictory and unreliable. A large shipbuilding programme for the Turkish Navy was announced in September. It included two "armoured ships," two cruisers of 10,000 tons, and two of 7500 tons, fifteen destroyers, four submarines, and six minelayers—to be built by contract in England, France, Germany, and Italy. This scheme appears to be still in the paper stage, from which, indeed, it is never likely to emerge, for the Angora Treasury is said to be bare.

There was much talk during the year of naval expansion by the leading States of South America. Brazil contemplates a programme of cruisers and smaller craft, while the Argentine Government may soon be in the market for submarines. Broadly speaking, however, the lesser navies show no desire to embark on ambitious naval plans. Probably they are deterred by the high cost of new construction, though uncertainty as to the future development of naval tactics may account in part for their hesitation.

* See THE ENGINEER of November 28th, 1924.

Locomotives of 1924.

THE year presented very little of interest as far as standard type locomotives are concerned. A few notable engines were, indeed, turned out, but no new types were evolved, and none of exceptional proportions were produced. Yet the end of the year was more than ordinarily interesting, because of the indications it gave of the efforts that are being made to introduce steam turbine and internal combustion locomotives. Unfortunately, more enterprise in these promising fields has been shown abroad than at home. We have, it is true, the great turbine locomotive which was exhibited at the British Empire Exhibition by the North British Locomotive Company, Limited, but, as Sir Hugh Reid explained in a letter which appeared in our issue of November 28th, the tests of that engine were held up expressly for six months, so that it might appear at Wembley. That interval enabled Escher, Wyss and Co. to put upon the road a type of turbine locomotive, designed by Herr Zoelly, and allowed the Hohenzollern Works to complete and exhibit a Diesel-electric locomotive designed by Dr. Lomonossoff for the Russian State Railways. Thus, although the North British turbine locomotive may claim priority in appearance, it has not yet progressed so far as the others. It was hoped at one time that the Kitson-Still locomotive would be well advanced before the year was out, but a change of policy some months ago entirely removed that possibility.

Exceptional Locomotives.

We reproduce in one of our Supplements to-day a photograph of the Reid-MacLeod turbine locomotive, made by the North British Locomotive Company, Limited, and repeat such few particulars as are available; but as the makers have wisely decided to say as little as may be about the engine until it has been put through its paces, on the test bed at least, we are unable to give our readers much information about it. It is propelled by two turbines placed one on each of the bogies, a high-pressure turbine at the trailing and a low-pressure turbine at the leading end. Both are geared down to drive the two driving axles on each bogie. Unlike the other turbine locomotives with which we deal to-day, the condenser is of the air-cooled evaporative type, and is carried on the engine frames. The boiler is of the ordinary locomotive type, but in the absence of exhaust a forced draught equipment is provided. A few further particulars and illustration may be found in our issue of April 25th, 1924.

About the foreign engines we have a good deal more information. Let us deal first with the Zoelly locomotive, as produced in Switzerland, then with the modification of it adopted by Krupps, and, finally,

with the Lomonossoff Diesel-electric locomotive. About the last-named we need, in fact, say very little, as it was quite recently fully described in our columns—see THE ENGINEER, September 19th and November 14th, 1924—and with regard to the Swiss Zoelly, we have little or no information to add to that given in our issue of November 7th, 1924. About the Krupp-Zoelly more may be said, as it has not yet been described. All three types are illustrated in one of our Supplements to-day.

The characteristic feature of the Zoelly design is the placing of the turbine transversely under the smoke-box and coupling it as closely as possible to two condensers, one on each side of the boiler barrel. The turbine—or turbines, for there is one for reverse—drive a jack shaft through fixed ratio double-reduction helical gearing, and a pin on the jack shaft drives an extension of the coupling-rod on each side. This general arrangement is followed in both the engines under consideration, but whereas the forward and reverse turbines are in a single casing, with the pinion on one side, in the Swiss design, they are separated in the German engine, and the gear is placed between them. In the Swiss engine the forward turbine, of the Zoelly type, develops normally 1000 horse-power and on emergency 1500 horse-power, and the reverse turbine, of the Curtis type, some 700 horse-power. In both engines all the pumps are carried almost centrally under the boiler barrel. The circulating water is cooled in the tender by spraying it upon a mass of Raschig rings, through which air is drawn by a rotary fan. For other details and for drawings of the engine and tender, we invite our readers to turn to THE ENGINEER of November 7th last. The locomotive weighs with its tender in working order 102 tons, and has been designed for a maximum speed of 47 miles per hour.

The Krupp engine, which is shown both by a drawing—Fig. 1—and by a reproduction from a photograph, is a far more powerful machine. Its forward turbine, built by Escher, Wyss and Co., develops 2000 brake horse-power at 6800 revolutions, and can take an emergency load of 2800 brake horse-power. The exhaust from the forward and reverse turbines are joined in one branch, so that some steam always passes into that turbine which happens to be out of use. Steam from this branch enters one of the condensers, and what is not reduced to water passes to the second condenser from the top of which the air is drawn. The circulating water passes successively through the first and second condenser, and thence returns to the tender, in which its temperature is reduced by the evaporative method. The cooler contains, as in the Swiss design, masses of Raschig rings, over which air is drawn. The feed pump, driven by a turbine through reducing gear, draws from a hotwell and delivers the water through three feed heaters to the boiler. Two of these preheaters receive the exhaust from the smaller turbines, which drive the pumps and fans, whilst through the third the hot gases from the smoke-box are circulated. The first two raise the water to 100 deg. Cent., and the third to about 140 deg. The air pump is of the Müller type, the jet of which is provided by the centrifugal circulating pump. The boiler is of the normal type, with a superheater, but a turbine-driven fan is provided in the smoke-box to induce a draught.

We turn now to the Diesel-electric locomotive, which was built by the Esslingen Locomotive Works for the Hohenzollern Locomotive Works, to the design of Dr. Lomonossoff, for the Russian State Railways. The most notable feature of the design is the employment of five independent electric motors, each driving, through reducing gearing, one of the five driving axles. There are no coupling rods or other mechanical connections between the wheels. The engine itself is a six-cylinder four-cycle submarine Diesel, capable of developing about 1200 horse-power at 450 revolutions per minute. It is coupled direct to an electric generator and the same shaft drives an exciter through two to one gearing, whilst an exciter for the exciter is driven by a belt The field of the last named is energised from a battery, and the engine is controlled by manipulation of this secondary exciter. The engine is heavy for its power, weighing 120 tons in working order. Its overall length is over 44ft., and the maximum speed is put at 31 miles per hour. It was fully described and some particulars of its trials on a test bed were given in THE ENGINEER on November 14th. It should be mentioned here that a modification of the design with mechanical gearing by Krupps is already in hand, and, furthermore, that the Esslingen Works are preparing to build a Diesel-driven locomotive with compressed air transmission.

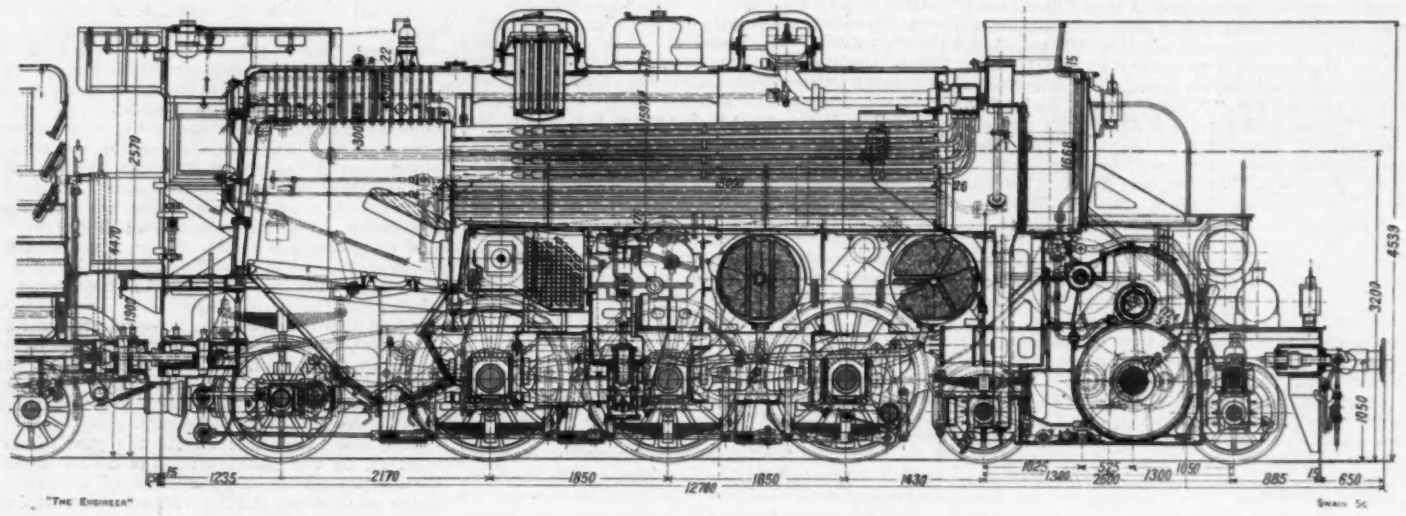


FIG. 1—KRUPP-ZOELLY STEAM TURBINE LOCOMOTIVE

The advent of the four locomotives we have mentioned is significant. It shows that at last a serious effort is being made to produce a prime-mover locomotive engine that can compete in efficiency with electric locomotives and retain that independence, the lack of which is a serious drawback to the electric machine for main-line operation. It need not be said that not one of the designs can be regarded as definitive, and that experience alone can show how far they are suitable to take their place in competition with normal locomotives.

Normal Locomotives.

We must now consider the ordinary locomotives of the year. There is, one fears, but little of interest to record. Since the grouping of the railways took place the chief mechanical engineers have found their time fully taken up in the effort to remove anomalies and to reduce the various types to more reasonable numbers. A process of limited standardisation, both in units and items, is going on, and until it is complete it is likely enough that no striking developments will appear upon British railways.

London, Midland and Scottish Railway.

The most notable company's engine of the year is the "Baltic" type tank locomotive, designed by Mr. Hughes for the London, Midland and Scottish Railway and fully described in our issues of April 25th and November 21st. The first of a batch of ten of these engines was steamed in March last. They are being used for heavy suburban traffic, and occasionally take the place of the well-known Horwich 4–6–0 tender engines on main-line work. Indeed, they may be regarded as little more than a modification of that class, for they differ but little from it in design, except in so far as the conversion from tender to tank necessitated. The frames, of course, had to be lengthened, and two pairs of carrying wheels provided to take the bunker. The grate area has been increased from 27 to 29.6 square feet. The cylinders, four in number, are 16½in. by 26in., and drive 6ft. 3in. wheels, giving, with 85 per cent. of a boiler pressure of 180 lb., a tractive effort of 29,000 lb. The evaporative surface is 1997 square feet, and a Horwich or "top-and-bottom" superheater provides 430 square feet of surface. The total weight in running order is just over 100 tons, and the length a little under 50ft. A weight diagram of the engine is given in Fig. 2.

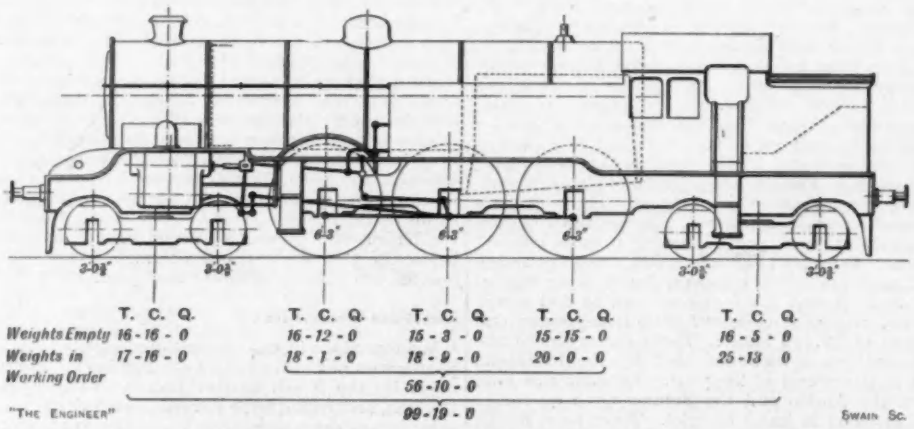


FIG. 2—L.M.S.R. BALTIC TANK ENGINE

Beside the ten Baltic tank engines to which we have just referred and which, by the way, are the only four-cylinder Baltics in this country, fifteen 4–6–0 express passenger engines with four cylinders were completed at Horwich. The boilers of these engines are of the Belpaire superheater type and are the same as those used for the Baltics. Five more of them will be built early in the present year, thus completing an order for twenty. The series will be numbered 10,455–10,474. At the Derby works forty new superheater compound passenger engines of the 4–4–0 type were built. They are numbered 1045 to 1084 and are practically identical with the preceding compound engines of the Midland Division, except that the wheels have been reduced in diameter from 7ft. to 6ft. 9in. and the diameter of the cylinders has been increased, the high-pressure cylinder from 19in. to 19½in. and the two low-pressure cylinders from 21in. to 21½in. These engines are provided with mechanical lubrication to the axle-boxes and to the cylinders. Many of the Midland 0–6–0 type goods engines are being built for the company. The type is an old one and dates, we believe, from 1911. It is the standard superheater goods engine of the Midland Division. Thirty of these engines are going through the shops at Derby, seventy at Crewe, and thirty at St. Rollox. At Crewe a newly designed Belpaire boiler has been fitted to the engines of the "George the Fifth" class, to

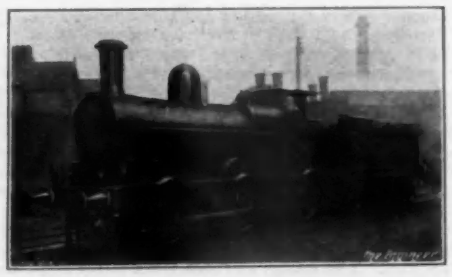


FIG. 3—L.M.S.R. GOODS ENGINE

engines of the 0–8–0 class, to engines of the 0–6–0 class, and to engines of the "Prince of Wales" class. A photograph of one of the 0–6–0 goods engines with the new boiler is reproduced herewith—Fig. 3. One of the Experiments is also being given a superheater and the same type of boiler.

Great Western Railway.

As far as the Great Western Railway is concerned, the appearance of the Great Bear in a new form will attract the greatest general interest. It is pretty well known that her pair of trailing wheels with inside bearings were never entirely satisfactory. They have been removed and she now appears, as will be seen from the photograph reproduced in one of our Supplements to-day, as a 4–6–0. Of necessity and as a result of the removal of the trailing wheels the boiler has had to be shortened, and the fire-box, which used to be well behind the last pair of driving wheels, is now further forward. She is now fitted with a six-wheel tender in place of the double-bogie tender which she originally had. A weight diagram of her in the new condition is given in Fig. 4. It is of interest to observe in passing that, following the new fashion, the steam pipes to the valve chests are brought outside the boiler. The famous engine retains her old number, namely, 111, but takes a new name and is now called Viscount Churchill.

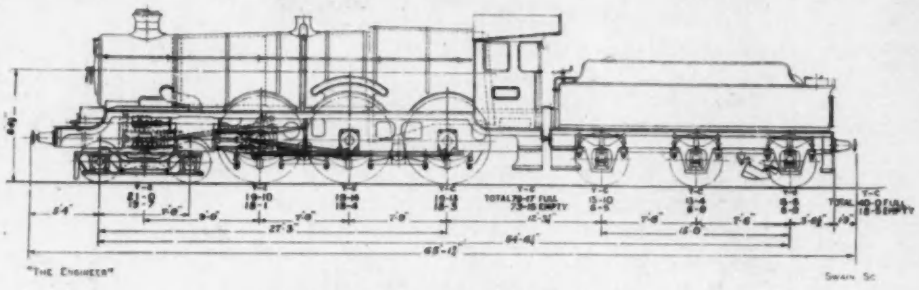


FIG. 4—G.W.R. THE CONVERTED GREAT BEAR

The Great Western Railway reports that fifty-nine engines, composed of the following types, were put into service:—4–6–0 passenger, "Castle" type; 2–8–0 T goods; 2–6–2 T goods; 0–6–2 T goods. The repairing programme was heavy, including 912 engines, 720 boilers and 545 tenders. In December the first engine of the 5600 class was completed for service to meet the demand for powerful engines in South Wales. An engine of the 2900 class (No. 2925) was re-designed to take 6ft. wheels and, during the change, the opportunity was taken to equip the engine with a cab of the "Castle" type. To cope with this heavy programme, contracts were placed outside for boilers, and for repairs to engines of the constituent companies. A large amount of work was dealt with in connection with the standardisation of the constituent companies' stock, including the fitting of Great Western details to reduce the stock of spare parts necessary in divisions where Great Western engines are working with those of other companies of the group. The 5600 engine referred to above, and illustrated by Fig. 5, is a 0–6–2 side tank engine with 4ft. 7½in. driving wheels and 3ft. 6in. radial wheels. The cylinders are 18 by 26, giving with a boiler pressure of 200 lb. a tractive effort of 25,800 lb. The evaporative surface is 1266.75 square feet, the superheater surface 82.2 square feet, and the grate area 20.35 square feet; the tanks carry 1900 gallons of water. In running order the engine weighs 68.12 tons.

London and North-Eastern Railway.

During the year the London and North-Eastern Railway put 246 new locomotives into service, some of them made in the various works of the company and some by locomotive manufacturing firms. These engines include thirty-three of Mr. Gresley's three-cylinder "Pacifics" of the type made familiar to everyone by the Flying Scotsman, which was exhibited at Wembley; twenty-four 4–4–0's and nineteen of Mr. Gresley's three-cylinder 2–6–0's. The construction of the Garratt locomotive at Beyer-Peacock's for the company has made good progress, and it is expected that the engine will go into service in a few weeks. It is of the 2–8–8–2 type and each of the two units has three cylinders, 18½in. by 26in. The engine will develop a tractive effort of 72,920 lb.

Southern Railway.

During the year ten new 4–6–0 mixed traffic engines, class "R 16," with double-bogie tenders, were turned out from the Eastleigh shops. They are fitted with superheaters and have cylinders 21in. diameter by 28in. stroke. The boiler has a working pressure of 180 lb. per square inch, and is identical with that of the latest express engines. The engines are fitted with vacuum pumps for the brakes driven from the left-hand crosshead.

A batch of five four-cylinder engines, constructed by Mr. Dugald Drummond in 1905, are being rebuilt as two-cylinder mixed traffic engines, and the first of them, No. 330, went into traffic at the end of the year. We understand that it is Mr. Maunsell's intention also to rebuild ten of the Drummond four-cylinder express engines as two-cylinder engines. They will be given cylinders 20½in. by 28in., long-travel piston valves, and a working steam pressure of 200 lb. per square inch. The existing double-bogie tenders, slightly altered, will be retained.

There were put into service on the S.W. section twenty 2–6–0 type mixed traffic engines, which were built at Woolwich as a post-war measure by the Government. They are identical with Mr. Maunsell's design of two-cylinder class "N" engines used on the S.E. and C. section, and have been found very useful on fast goods work between Feltham and Southampton, and several of them are now being employed on passenger and goods work over the heavy roads west of Exeter.

A batch of ten new 2–6–4 passenger tank engines are in hand at the Ashford works for the S.E. and C. section. They are superheater engines having cylinders 19in. by 28in., and a working pressure of 200 lb. per square inch, and the tanks will carry 2000 gallons of water. They are to Mr. Maunsell's original design and are the same as engine No. 790, which has been in service since 1917.

An order for twenty new 4–6–0 express tender

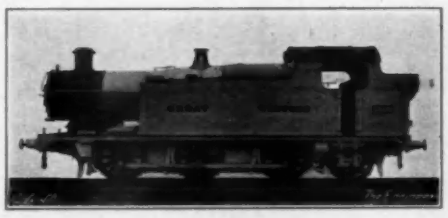


FIG. 5—G.W.R. GOODS TANK ENGINE

engines was recently placed with the North British Locomotive Company, for delivery in the early summer. These engines will be very similar to the latest express passenger engines built for the London and South-Western Railway by Mr. Urie, but modified as regards the boiler pressure—which has been increased to 200 lb. per square inch—and the cylinders—which have been reduced to 20½in. diameter. Other slight alterations in the original design have also been effected.

Makers' Locomotives.

Whilst the locomotive trade was not in a really flourishing condition during the year, a good deal of interesting work for foreign railways was carried out. In what follows we take the makers in alphabetical order.

Amongst the engines completed by Sir W. G. Armstrong, Whitworth and Co., Limited, we may mention, besides the oil-fired locomotive for the Buenos Aires Great Southern Railway, which was exhibited at Wembley and described in our series of articles on the Exhibition—see THE ENGINEER, July 25th, 1924—a 4–8–2 locomotive for the Nigerian Railways, which are on the 3ft. 6in. gauge. The cylinders are 20in. by 24in., the evaporative area 1807 square feet, and there are 315 square feet of superheater surface. The grate area is 38 square feet. The working pressure is 180 lb. per square inch, and at 90 per cent. of it the tractive effort is 34,560 lb. The total weight of the engine in working order is 70 tons 8 cwt., and its double-bogie tender weighs 36 tons 14 cwt.

The most important contract undertaken by the Avonside Engine Company, of Bristol, during the year was the construction of fourteen locomotives for the Commissioners for the Port of Calcutta. These engines were speciálly designed to meet the expanding requirements of the Port Authorities in dealing with the heavy traffic which now passes through the port. They are of the saddle-tank type with six wheels coupled. The cylinders, which are outside, are 16in. diameter by 24in. stroke. With 80 per cent. of the boiler pressure, which is 170 lb., the tractive effort is 18,165 lb. The gauge of the port railways is 5ft. 6in. Most of the engines are fitted with Hulburd boiler cleaners, with hot water injectors, and with duplex feed pumps.

Amongst the locomotives turned out during the year by W. G. Bagnall, Limited, the most interesting is perhaps the fireless engine Unique, which we illustrate by Fig. 6. It was supplied to Edward Lloyd's Paper Mills at Sittingbourne, and is, we believe, the largest of its kind in this country. It weighs in working order 26 tons, and has cylinders 18½in. by 18in. The reservoir pressure is 220 lb., and the working pressure 80 lb. The coupled wheels are 2ft. 9½in. diameter, and the bogie wheels 1ft. 10in. The gauge of the works railway is 2ft. 6in. Other locomotives

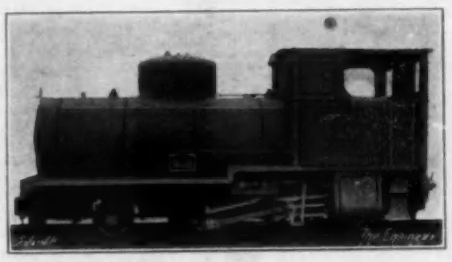


FIG. 6—FIRELESS ENGINE—BAGNALL

turned out by the firm were eight 2–6–2 tank engines for the Lantaro Nitrate Company, Chile, and one 0–6–0 tank engine for the Nigerian Railways. Five 4–6–0 passenger engines, with 16½in. by 22in. cylinders, 3ft. 3½in. gauge, for the Madras and Southern Mahratta Railway, are now going through the shops.

It may be of interest to note that Wm. Beardmore and Co., Limited, have taken up the Caprotti valve gear for locomotives. In that gear the ordinary slide or piston valves are replaced by drop valves operated by cams. It has already been tried with considerable success on Italian railways.

Amongst the engines turned out by Beyer, Peacock and Co., Limited, we may mention some 2–8–2 shunting tank engines for the East Indian Railway, illustrated in our issue of April 18th, 1924. Their boilers are of the Belpaire type, designed for 180 lb. pressure, and working at 160 lb. The cylinders are 22in. by 26in., driving coupled wheels 4ft. 3in. in diameter. The adhesive weight is 67.2 tons, and the total weight 90.43 tons. The total heating surface is 1567½ square feet, and the grate area 27 square feet. The engines are not fitted with superheaters, but nevertheless they have piston valves and automatic by-pass valves.

Five metre-gauge locomotives of the Mallet type were built by the same firm for exceptional service on the Burmese railway. They are of the compound articulated type with the low-pressure cylinders 24½in.

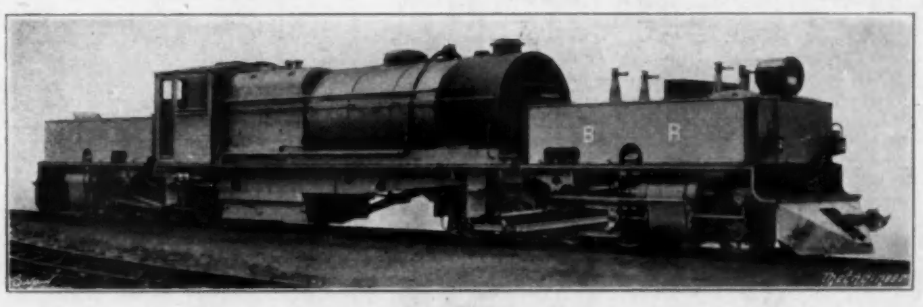


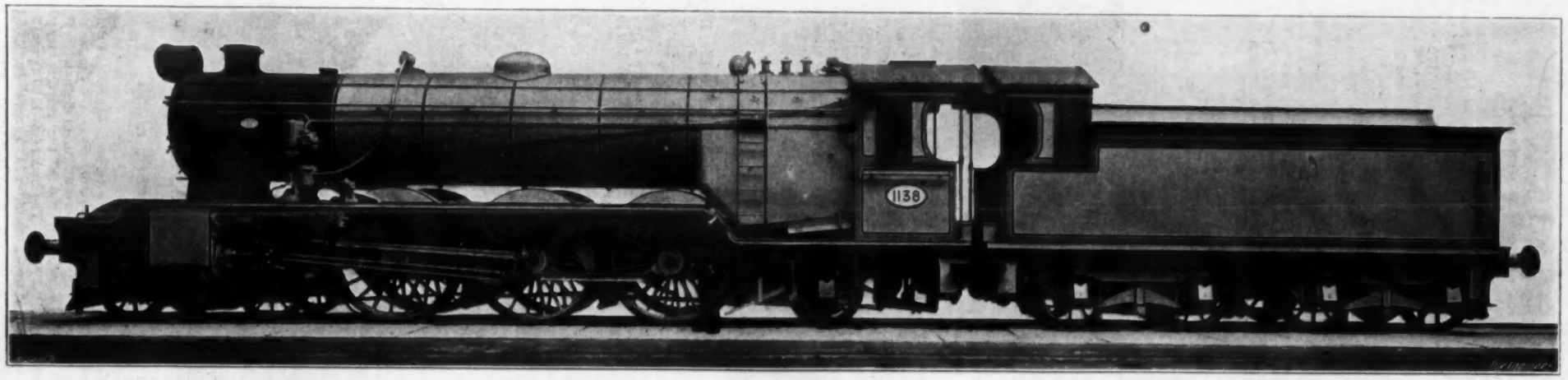
FIG. 7—BURMA RAILWAYS—GARRATT LOCOMOTIVE—BEYER, PEACOCK

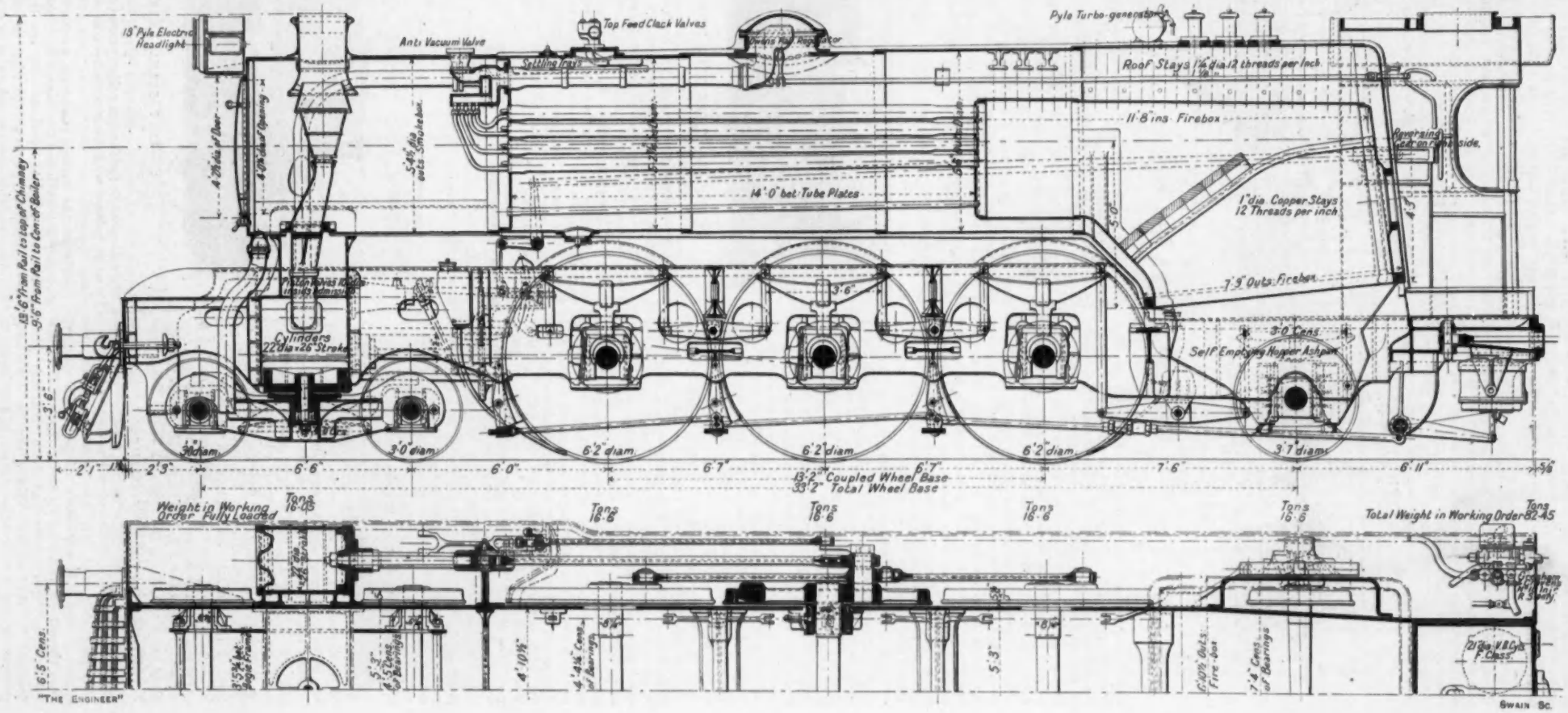
by 20in. on the leading engine, and the high-pressure cylinders 16½in. by 20in. on the rear engine. The driving wheels are 39in. in diameter. With a working pressure of 180 lb. the starting tractive effort is 30,000 lb. The boiler has 1180 square feet of evaporating surface, 224 square feet of superheated surface, and 33 square feet of grate area. They will haul trains of 140 tons up 1 in 25 at 10 miles an hour, and trains of 220 tons up 1 in 40 at higher speeds.

The engine shown by Fig. 7 was delivered towards the end of the year by Beyer, Peacock and Co., Limited, Gorton, Manchester, to the Burma Railways Company, Limited, for operating the Lashio branch of the Burma Railway on which there are long grades

EAST INDIAN RAILWAY—SIX-COUPLED PASSENGER LOCOMOTIVE

KITSON AND CO., LIMITED, LEEDS, ENGINEERS





of 1 in 25, in one case involving a continuous climb of 17 miles, associated with many curves of 337ft. radius. The engine, in fact, is designed to take curves of 250ft. The duty laid down for this gradient was a gross train load of 180 tons exclusive of weight of engine.

The engine has now passed its test, easily hauling the specified load. Indeed, 200 tons have been hauled, and we understand that this is by no means the limit of the engine's capacity. On gradients of 1 in 40 a train load of 320 tons has been handled. The engine is of the 2–8–8–2 type, the maximum rail load being limited to 10½ tons per axle, as the engine has to work on a permanent way laid with 45 lb. rails.

The leading dimensions and ratios are as follows :—

Cylinders (four), diameter	15½in. by 20in.
Wheels, coupled, diameter	3ft. 3in.
Wheel base—	
Coupled (each group)	10ft. 6in.
Rigid	7ft. 0½in.
Total (each group)	16ft. 9in.
Total engine	58ft. 6in.
Evaporative surface	1735.0 square feet
Superheater surface	365.0 square feet
Grate area	43.9 square feet
Working pressure	180 lb. per sq. in.
Weight of engine in working order	99.075 tons
Water capacity	2000 gallons
Coal capacity	5 tons
Tractive force at 90 per cent. boiler pressure	39,920 lb.

The grate is of the rocking finger type actuated either by hand or steam combined with a drop, the ashpan being of the self-emptying hopper type.

The engine was built under the supervision and inspection of Messrs. Rendel, Palmer and Tritton, consulting engineers, in consultation with Mr. H. A. Craig, the locomotive superintendent.

The Hunslet Engine Company, of Leeds, turned out two rather interesting locomotives for Chile. These engines run on a mining line of 2ft. 6in. gauge, which works in conjunction with the Antofagasta and Bolivia Railways, and they are somewhat similar to those of that railway save that they are fitted with an oil-burning apparatus which is of the Kermode type. They have electric headlights of the Sunbeam pattern. The illustration we reproduce in a Supplement gives an idea of their curious appearance. The cylinders are 16½in. by 20in., the diameter of the coupled wheels is 3ft. 1½in. The rigid wheel base is 10ft. 7in., and the total wheel base of the engine alone is 17ft. 1in. The total heating surface is 1236 square feet, and the grate area 20.1 square feet. The working pressure is 180 lb. The engine and tender in working order turn the scale at 81 tons 17 cwt., and at 75 per cent. of the boiler pressure of 180 lb. the tractive effort developed is 19,600 lb. On the level the engines will haul over 1000 tons, and they will take 262 tons up a gradient of 1 in 50. They are designed to round curves of 240ft. radius.

We illustrate on page 12 one of two locomotives recently completed by Kitson and Co., Leeds, for the East Indian Railway to the designs and under the inspection of Messrs. Rendel, Palmer and Tritton. They are powerful passenger engines with 6ft. 2in. wheels driven by a pair of outside cylinders 22in. in diameter by 26in. stroke. The boilers are built for 180 lb. pressure, but will ordinarily be worked at 160 lb. At the latter pressure the tractive force is about 27,500 lb. The axle load throughout is about 16½ tons, engine and tender, with the exception of the leading bogie, which has 8 tons on each axle. Thus the total weight of the engine is nearly 82½ tons and the weight of the tender 61½ tons, or nearly 144 tons for the two. The rigid wheel base of the engine is 13ft. 2in. The gauge is 5ft. 6in. The bogie is of the standard type, but the radial trailing wheels have Cortazzi boxes. All the axle-boxes are arranged in such a manner that the keeps can be removed to permit examination of the journals. The bearing springs are placed above the axles and compensation is effected in two groups, one group covering the driving and trailing wheels and the other the four-wheeled bogie. The fire-box has a grate area of 44 square feet, and as the coal that has to be burnt is of a low calorific value with a large percentage of ash, the grate is of the rocker bar type in two sections with a drop grate at the front end. The rocker bars may be operated by steam or by hand. The brick arch is supported by four 3in. tubes. The total evaporative surface amounts to 1476 square feet and there are 370 square feet of superheater surface. It should, by the way, be noticed that the fire-box is extended well into the barrel and the great length of the smoke-box will also be observed. The superheater header is of the M. and L. Superheater Company's "Stirling" type. It has an automatic anti-vacuum valve on top.

The drawing gives information about other points of special interest, but attention may be directed to the regulator, which is of the Owen's type, and to the feed arrangements. On the left side of the engine is a Weir feed pump and on the right under the foot plate a Gresham and Craven No. 10 injector. Both deliver to check valves on the top of the boiler, through which the feed passes on to settling trays. On the top of the fire-box three Ross safety valves are arranged in a row, and just in front of them may be seen a little turbo-alternator which supplies electric current for the head lamp.

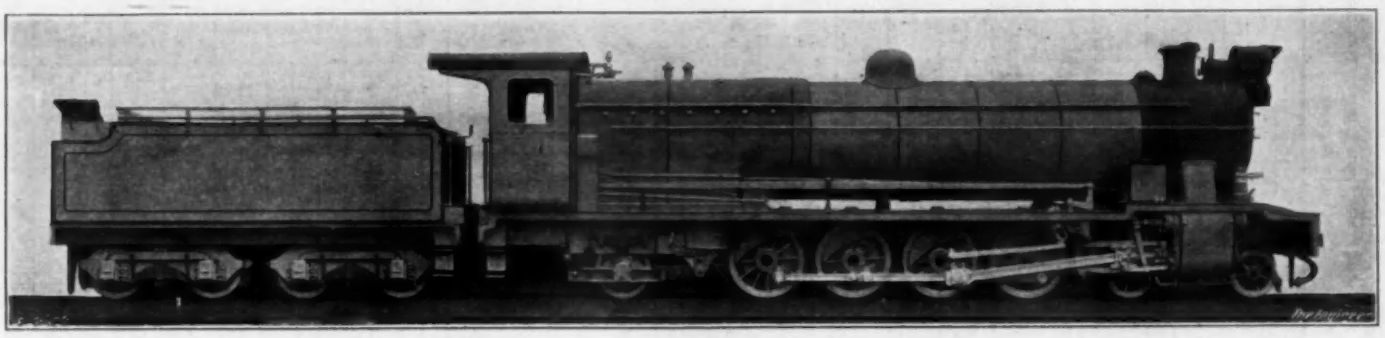


FIG. 8—GOLD COAST RAILWAY, EIGHT-COUPLED GOODS ENGINE—VULCAN

FIG. 9—NITRATE RAILWAYS, TANK ENGINE—YORKSHIRE ENGINE CO.

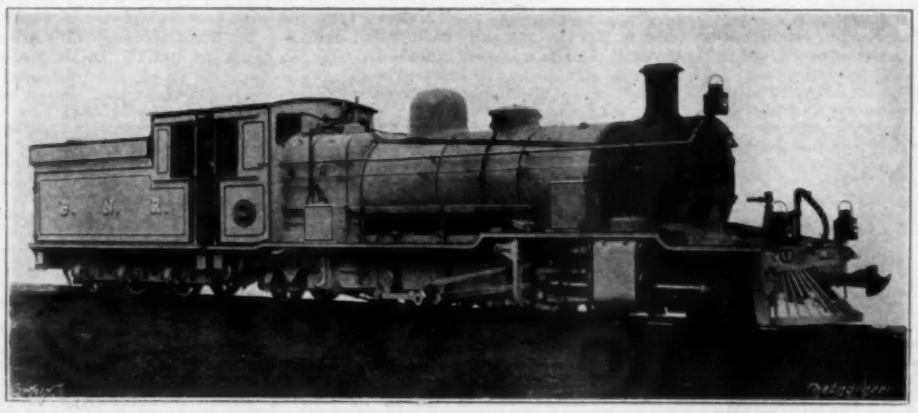


FIG. 10—BENGAL-NAGPUR RAILWAY, EIGHT-COUPLED ENGINE—YORKSHIRE ENGINE CO.

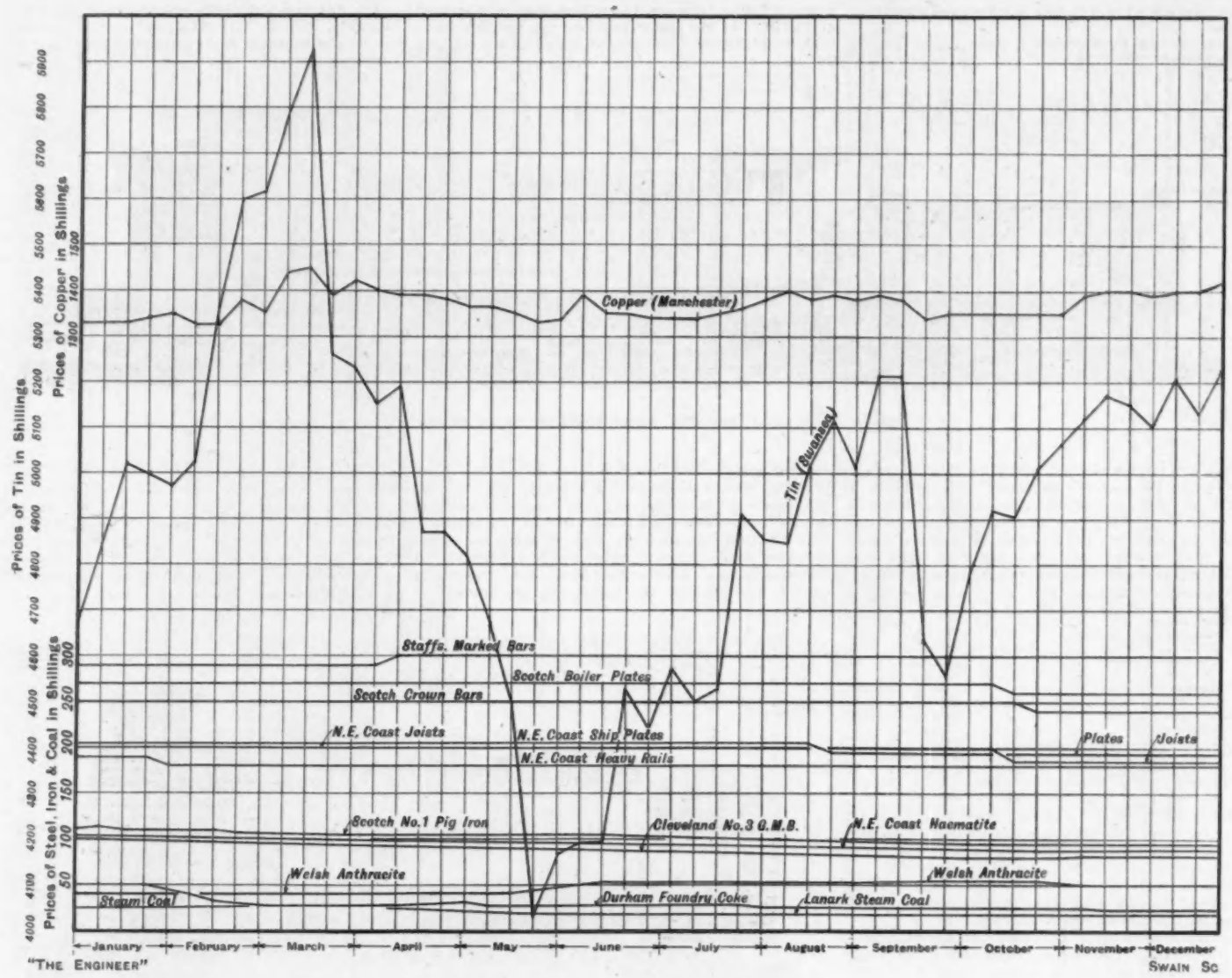
The tender is carried on two bogies with 3ft. 7in. wheels with a total wheel base of 18ft. Its tank holds 4500 gallons of water and its hopper 10 tons of coal.

The North British Locomotive Company, Limited, was engaged on the construction of ten heavy 4–6–2 type engines for the Western Australian Railways, which are on the 3ft. 6in. gauge. One of these engines is illustrated in a Supplement to-day. They have cylinders 19in. by 26in., driving wheels 4ft. 6in. in diameter. The working pressure is 160 lb. per square inch, the total evaporative surface is 1556 square feet, that of the superheater 363 square feet, and the grate area is 35 square feet. The boiler pressure is 160 lb., and at 75 per cent. of it the tractive effort is 20,850 lb. In working order the engine weighs 64 tons 6 cwt., and the tender 39 tons 17 cwt.

The Vulcan Foundry Company, Limited, sent away a good many locomotives out of a batch of 55 for the North-Western Railway of the Indian States system. These engines are of the 2–8–0 type with six-wheeled tenders, and run on a 5ft. 6in. gauge. They have cylinders 22in. by 26in., 1692 square feet of evaporative surface, 390 square feet of superheated surface, and a grate area of 32 square feet. The diameter of the driving wheels is 4ft. 8½in., and the working pressure 160 lb. The weight of the engines alone is 72¾ tons, and of the engine and tender together 120 tons. The tank carries 4000 gallons and the bunkers 7½ tons of coal.

Amongst other Vulcan engines we may mention a score of 2–8–0 heavy goods engines and tenders for the Bengal-Nagpur Railway; forty 4–6–0 passenger engines and tenders for the East Indian Railway, and four 4–8–2 goods engines and tenders for the Gold Coast Railway. Some of the engines for the East Indian Railway are being shipped in a completely erected state at Birkenhead for India. Besides these locomotives the firm has in hand two 4–6–0 engines and tenders for the Madras and Southern Mahratta Railway, two 4–6–0 for H.E.H. the Nizam's Guaranteed State

FLUCTUATIONS IN THE PRICES OF ENGINEERING MATERIALS DURING 1924



The prices are all given in shillings. It should be noted that separate zeros are given for tin and copper, while the scales for these two metals are different from those for other commodities. The horizontal divisions are weeks, taken from Friday, January 4th, to Friday, December 19th. In the case of coals the prices are those quoted for export, as it is practically impossible to give market prices for industrial consumption at home. Thus in South Wales the prices for inland consumption are sometimes 2s. per ton above, and at other times as much below, export prices. In Scotland the pithead price is generally some 2s. below the f.o.b. price, but carriage costs from 4s. to 7s. 6d., according to the distance. In the Midlands home prices are generally from 2s. 6d. to 4s. per ton less than those for export.

Railways; eighteen 4–8–0 for the Uganda Railway; twenty-five 2–6–4 heavy tank engines for the Buenos Aires Great Southern; and five 2–8–2 engines for the Nigerian Railways. The work in hand for England consists of twenty 0–6–0 tank locomotives and twenty-five 4–4–0 passenger engines and tenders for the London, Midland and Scottish. We illustrate by Fig. 8 one of the engines for the Gold Coast. It has cylinders 19½in. by 24in., driving coupled wheels 3ft. 9in. diameter. The working pressure is 180 lb., and the boilers are fitted with Robinson's superheaters. The evaporating surface is 1973 square feet, the superheated surface 347 square feet. The area of the grate is 32.14 square feet. The total weight of the engine is 73.65 tons, and of the tender 32.75 tons. The engine, it will be seen, is a large one for a 3ft. 6in. gauge, and the great length of its boiler will not escape attention.

During the year the Yorkshire Engine Company, Limited, of Sheffield, turned out two new types of locomotives. They are 4–8–4 tank locomotives, of which five were built, for the Nitrate Railways, and 2–8–2 engines, with six-wheel tenders, of which four were built, for the Bengal-Nagpur Railway. Illustrations of these two types are given in Figs. 9 and 10, and the main particulars are tabulated below :—

	Nitrate Railways.	Bengal-Nagpur Railway.
Gauge	4ft. 8½in.	2ft. 6in.
Cylinders	22in. dia. by 20in. stroke	16in. dia. by 18in. stroke
Coupled wheels	3ft. 6in. dia.	2ft. 10in. dia.
Superheater	M.L.S.	Robinson
Number of large tubes	22	18
Diameter of large tubes	5½in.	5½in.
Number of small tubes	154	96
Diameter of small tubes	2in.	2in.
Heating surface—		
Tubes	1781 sq. ft.	916 sq. ft.
Fire-box	164 sq. ft.	79 sq. ft.
Total	1945 sq. ft.	995 sq. ft.
Superheating surface, internal	362 sq. ft.	173.5 sq. ft.
Grate area	39.75 sq. ft.	20.5 sq. ft.
Adhesive weight	68 tons	29.2 tons
Weight of engine in working order	112 tons	40.75 tons
Weight of tender in working order	—	18.77 tons
Working pressure per sq. in.	180 lb.	160 lb.
Water capacity	3400 galls.	1700 galls.
Fuel capacity	1000 galls.	170 cu. ft.
Type of fuel	Oil	Coal

The Nagpur engines were built to the designs and under the supervision of Sir John Wolfe Barry and Partners, and the Nitrate engines under the inspection of the Robert W. Hunt Company. The latter engines have to work heavy loads up a practically continuous gradient of 1 in 25, and have to round curves of 280ft. radius. All the wheels have flanges of full thickness, and as the wheels are only 3ft. 6in. in diameter, the very short stroke, for a standard gauge engine, of 20in. had to be adopted. They have bar frames. These locomotives have been at work for several months, and are, we hear, giving great satisfaction.

We illustrate as a curiosity of the year what is probably the longest locomotive in the world. It was made by the American Locomotive Company for the Chesapeake and Ohio Railroad, and the total length of engine and tender is 97ft. 9in. It is of the "Mallet" type, but with four high-pressure cylinders, each 23in. diameter by 32in. stroke. The driving wheels are 57in. in diameter and the boiler pressure is 205 lb., giving a maximum tractive effort of 103,500 lb. The vast boiler has an evaporative surface of 6443 square feet and a superheated surface of 1885 square feet. The grate is getting on for 109 square feet in area, and is, of course, fired mechanically. The fire-box is no less than 17ft. long by 8ft. wide, and it is fitted with a Gaines arch. The engine itself weighs over 252 tons and the tender something under 94 tons.

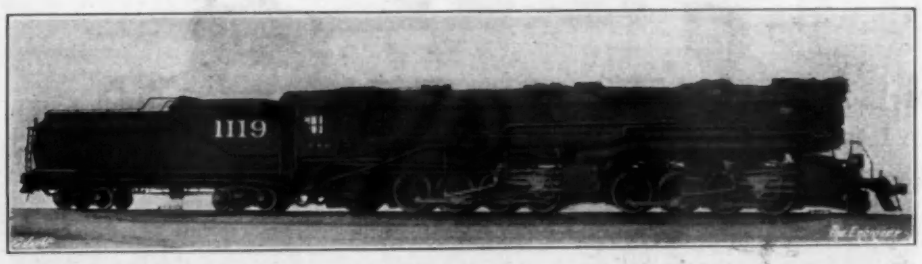


FIG. 11—CHESAPEAKE AND OHIO RAILWAY—MALLET SIMPLE LOCOMOTIVE—AMERICAN LOCOMOTIVE CO.

Railway Matters.

THE first issue of the *Railway Advertiser*, the official organ of the Egyptian State Railways, which was published on December 4th, contains a long list of tenders invited. The journal is printed in the English, French, and Egyptian languages.

THE cost of living on December 1st being 81 points above the 1914 figure, as compared with 70 points on June 1st, the increase of 11 points will mean that from the 1st inst. the wages of all railwaymen in the conciliation scheme will be advanced by two shillings per week, being one shilling for every five points.

CORROBORATION of the suggestion in this column on October 17th that the apparently large number of older vehicles on the Southern Railway at the present time was due to the better stock being prepared for electrification, was forthcoming when a deputation from Eastbourne waited recently on Sir Herbert Walker, who stated that the number withdrawn was 600.

THE question of unemployment was raised on the motion for the adjournment of the House of Commons for the Christmas holidays, and in his speech in reply Mr. Guinness—Financial Secretary to the Treasury—gave some particulars of what was being done. Included in them were the programmes of the railway companies as related in our Journal page of December 12th and 19th.

THE Canals (Continuance of Charging Powers) Bill was read a third time in the Commons before Parliament rose. It is a Government Bill to continue powers given to the Ministry of Transport which expire on February 15th. In some remarks he made on the subject of the future of Canals, Colonel Ashley said he had under consideration a scheme for "one particular canal in the Midlands."

THE provision of automatic signalling on the Metropolitan Railway not only allowed for an increase of 60 per cent. in the number of trains and avoided the cost of new lines but, by closing signal-boxes, has saved £12,000 a year in signalmen's wages. At one point—on the country lines, we believe—an expenditure of £3000 in that direction has effected an economy of £1000 a year. Similarly, on the City—late City and South London—Railway automatic signalling has allowed eleven boxes to be entirely dispensed with and four others need only be opened when certain emergencies arise.

JUDGING by a statement made by the Minister for Industry and Commerce in the Northern Parliament on the 19th ult., a very interesting situation is likely to arise over the proposed transfer of the Ballycastle Railway to the London, Midland and Scottish Railway. It has been stated that notice had been given of a Bill for the transfer, but the Minister said that when the application came before it he presumed that the Northern Parliament would refuse it on the ground that it had not the power. We take this observation to mean that, unlike the Free State, the Northern Parliament has not yet accepted responsibility for the railways in the Northern Territory.

THE retirement on the 31st ult. of Mr. W. Marriott, the engineer and traffic manager of the Midland and Great Northern Joint Railway, is announced. Mr. Marriott has been connected with the railways now in the Midland and Great Northern Joint line since 1881, and was made the engineer to one of them in 1883, and locomotive superintendent in 1884. Of late years he has been prominent in the use and advocacy of reinforced concrete—see THE ENGINEER of December 9th, 1921. The position hitherto held by Mr. Marriott has been divided, the resident civil engineer being Mr. A. E. Langley and the resident mechanical engineer Mr. W. E. Newman, both stationed at Melton Constable.

THE Wellington correspondent of *The Times*, cabling under date December 25th, says that Sir Sam Fay and Sir Vincent Raven, the Commissioners appointed to inquire into the administration of the New Zealand railways, have recommended that the railway accounts be separated from those of the Treasury. They further recommend that the Railway Department be managed by a board of three members, that equipment and rolling stock be modernised, and time-tables and rates be revised. It is recommended that the railways be made responsible for interest, depreciation, and renewal charges except for net losses on development, which should be recouped from tourist and excursion traffic. The cable advice adds that the Government, is, in general, adopting the recommendations.

THE recently issued railway statistics for September last give the results for the first nine months of the present year and compare them with those for the corresponding period of 1923. Passenger journeys increased by 0.6 per cent. and passenger receipts by 3.5 per cent. There was a decrease of 4.6 per cent. in season tickets and of 2 per cent. in parcels, and so the total passenger receipts were only 1.7 per cent. higher. Passenger train mileage was 2.1 per cent. more. Whilst general merchandise was 4.4 per cent. greater in tonnage, the receipts were 4.5 per cent. less—owing presumably to reductions in rates—and, in addition, there were big decreases in live stock traffic and in coal. The result was a decrease of 1.3 per cent. in freight tonnage and of 4.1 per cent. in freight receipts. Freight traffic mileage was up 1 per cent.

IN view of representations made to the Government by leaders of labour, supported by the Bilbao Chamber of Commerce, orders for thirty locomotives and seven hundred cars for the use of the Norte Railway, which it had been intended to place abroad—probably in Belgium—will be allotted to native workshops. The town, which owes its prosperity almost entirely to the extensive products of the deposits of iron ore, situated on the left bank of the Nervion, and contains a large number of iron foundries, has lately been suffering from severe trade depression, which had serious results for the majority of workshops, and but for the new contracts to be placed, it was intended to close down several of the forges and discharge several thousands of men. Among foreign competitors for orders for locomotives and other railway supplies were German and Belgian firms. German competition with national factories is likely to become keener in view of the recent acquisition by the Krupp interests of large locomotive works in Spain.

Notes and Memoranda.

ACCORDING to Mr. J. A. Vaughan, the cost of winding ore in the gold mines of the Transvaal is about 1s. per ton from a depth of 3000ft., or 3s. per ton from 5700ft. In 1906 the cost was about 1s. 3d. from a depth of 1200ft.

THERE was recently dug up in Seattle a piece of wooden water main laid in 1874. It is of fir, 10in. in diameter, with a 2in. hole bored down the centre, and 6ft. long. From an illustration published in the *Engineering News-Record* it appears to be in a good state of preservation.

BORING in the vicinity of Gull Pond, Newfoundland, situated about 14 miles from the coastal copper deposits of Notre Dame Bay, is said to have proved the occurrence of about 2,000,000 tons of copper ore in the form of chalcopyrite, giving an average of about 3 per cent. of metallic copper.

AN instrument, called a carboscope, has been devised by Messrs. Kemp, M'Laren and Thomson, of Edinburgh, by means of which, it is said, the ash content of coal can be quickly estimated. It employs the principle that carbonaceous materials are more transparent to X rays than are ash and other dirt.

A LIGNITE carboniser recently designed by the American Bureau of Mines after extensive investigations should, it is believed, result in the ultimate solution of the important problem of economic utilisation of the lignites of the North-West. These lignites comprise nearly one-third of the total solid fuel resources of the United States.

AN ingenious instrument for detecting the settlement of the floors of a building under repair has been used in America. It comprised three lengths of 1in. by 2in. fir cut just so long that they were slightly bowed when jammed between the ceiling and the floor. Light pointed sticks set between pairs of the bows were held in place normally, but dropped out, and thus gave warning if settlement occurred and the curvature of the bows was altered.

THE main seam of the Fushun Colliery, in Manchuria, varies, according to the *Far Eastern Review*, from 80ft. to 480ft. thick, and is overlaid by 40ft. of soil. The main part of the overburden is oil shale containing 7 per cent. of crude oil, and it is claimed that 1,500,000 tons of oil can be produced annually for two centuries. An initial distillation plant with a capacity of 50,000 tons of oil per year, is about to be erected. It is suggested that the industry will ultimately involve a capital of some ten millions sterling.

A FACTORY for making Portland cement is being put up at Redwood City, California, and will use, as raw material, a layer of oyster shells and clay lying on the bottom of San Francisco Bay, mixed with a small proportion of gypsum. The material is to be won by means of a suction dredger with a rotary cutter. The scheme suggests the possibility of similarly utilising the great deposits of oyster shells around the shores of Vancouver Island, which are locally assumed to be the rubbish heaps of the aboriginal Indians.

WITH the exception of nitro-glycerine, there are few liquid organic bodies which contain an excess of oxygen for their own combustion, although ethylene glycol dinitrate does contain the theoretical amount of oxygen to convert the carbon into carbon dioxide and the hydrogen into water. This substance should therefore, says Mr. Charles L. Rees, come the nearest to being a substitute for nitro-glycerine. It produces a stable dinitrate and can be readily synthesised from alcohol, and has been used to a considerable extent in spite of the fact that it is more volatile than nitro-glycerine.

ACCIDENTS at coal mines in the United States during October, 1924, caused the death of 154 men, according to reports furnished by State mine inspectors to the Department of the Interior through the Bureau of Mines. The production of coal for the month was 54,487,000 tons, hence the fatality rate was 2.83 per million tons, as compared with 3.11 for October last year. At bituminous mines throughout the country 123 men were killed and the fatality rate was 2.63 per million tons, as against 2.85 in October, 1923. At anthracite mines in Pennsylvania the number of fatalities was 31, indicating a fatality rate of 4.04, as compared with 4.59 for the same month last year.

THE only explosive which has been found to be satisfactory for shooting oil wells is nitro-glycerine, and several attempts have been made to find a substitute since no railway will transport liquid nitro-glycerine, and consequently it has to be manufactured in small uneconomical plants situated near enough to the oilfields to enable it to be transported by wagon or truck. Its advantages for shooting oil wells are its liquid state and consequent adaptability for filling the long cylindrical cans used for lowering the explosive into the well and its high density of loading and sensitiveness, so that it can be exploded without failure by a small cap placed on a heavy "Godevil" which can be dropped into the well, thus avoiding the use of long electric lead wires which would be necessary for a large electric detonator.

LECTURING on rustless iron, before the Manchester Association of Engineers, Mr. H. S. Primrose said that quite recently a new process had been evolved whereby mild stainless steel could be produced more cheaply than by the methods previously in use. The future of commercial development and wide engineering application undoubtedly lay with the low-carbon alloys containing chromium. The great hindrance hitherto to the rapid progress of commercial expansion had, however, been the high cost of production of such steel. With the new method—the Hamilton-Evans process—using chrome ore and ferro-silicon, which were both comparatively cheap and easily obtainable commodities, this direct process put an entirely different commercial phase on the rustless-steel industry. The cost of producing mild stainless steel in ingot form by the ferro-chrome process was about £65 per ton, but by the new process ingots were made at £30 per ton. Mr. Primrose also said that castings in mild stainless steel were now being produced on a commercial scale, and that those castings, when descaled by sand blasting and pickling, were rustless without polishing.

Miscellanea.

THE wreck of the monitor Glatton is to be removed from the outer harbour at Dover.

THE official estimation of the population of China in 1923 is 436,094,953.

THE wharf facilities at Dar-es-Salaam, East Africa, are to be improved, at a cost of approximately £100,000.

SEVERAL permits for prospecting for copper ore have recently been granted in the French colony of Algeria.

LAST year the Forests Commission of Victoria planted over a million trees, of which about 99 per cent. were conifers.

PLANS for a 3,000,000 dollar power plant at Slave Falls, Manitoba, and a 2,000,000-dollar transmission line to Winnipeg have been completed.

IT is proposed to utilise the Gersoppa Falls, in Mysore, for the generation of over 30,000 horse-power. According to *Indian Engineering*, the falls are about 900ft. high.

IT is estimated that the German plant put into the Tsingtao waterworks will last only another ten years, and that the Japanese pumps will be worn out in twenty years.

THE Tyne shipbuilding output during the past year totalled sixty-five vessels, with a tonnage of 274,557, an increase of twenty vessels and 120,499 tons over last year.

THE scheme of the Greenock Harbour Trust for the deepening and enlarging of the Garvel graving dock, at a cost of over £60,000, will, it is understood, not be proceeded with.

IT is reported that a large crack has been discovered amidships in the Majestic, and it is believed to have been caused by the liner being strained during the recent bad weather.

THE prospects of proving oil in commercial quantities in the Lake Albert regions of Uganda seem more bright than for some time past, though it is too early to express a definite opinion.

PATENT applications totalled over 30,000 during the past twelve months. While this is 1000 fewer than for 1923, the latter period showed a decrease of over 3000 compared with 1922.

ALTHOUGH Bengal has large working coalfields, South African coal is being imported into India in increasing quantities. The reason is said to be the low grade and the poor cleaning of the Bengal fuel.

THE motor omnibus service which was recently started in Shanghai already includes twenty-four 40 horse-power Tilling-Stevens vehicles, each having thirty seats, and an equal number of vehicles will be added shortly.

THE output of the Richmond Main Colliery in the South Maitland coalfield, Australia, was 3097 tons on December 9th, which is believed to be a world's record for a one-shaft colliery. The depth from which the coal is wound is not stated.

IT is proposed to furnish a new water supply to the East Bay cities of California at a cost of 39,000,000 dollars. The scheme involves the laying of a pipe line 81 miles long and the construction of a reservoir having a capacity of a million acre-feet.

A NEW machinery works has just been started by a few German residents in Chungking, China, under the name of Cyclops Works, Limited. The works undertakes all kinds of repairing, including the overhauling of steamers. The chief engineer is Mr. Nielsen.

A GREAT undeveloped area of 10,000,000 acres in North-Western Quebec will be opened up by a new railway having a length of 230 miles, which will connect the National Trans-continental line, running through the northern belt, with the direct lines to Ottawa and Montreal.

THE output of copper from the Union Minière, Katanga, Congo, from January to October of this year was 70,821 metric tons, as compared with 56,956 tons for the whole of last year. The total ore reserves at the end of December, 1923, amounted to 68,300,000 tons, containing 4,575,000 tons of copper.

ONE of the 75,000 horse-power hydraulic turbines of the Niagara Falls Power Company was recently shut down through some solid object getting into the casing and damaging the guide vanes. The safety links of several vanes broke and the vanes, fouling the runner, were damaged on their edges. Stops have now been fitted to prevent another similar accident. The set was shut down in four minutes.

THE Birmingham Fire Brigade has acquired a new rescue tender for use in such emergencies as the breakdown of the ammonia plant at an ice factory or serious gas escapes at gasworks or gas mains. The equipment includes eight sets of Proto-breathing apparatus, each sufficient to provide artificial respiration for one and a-half hours, also eight spare oxygen cylinders, which will add a further one and a-half hours to each apparatus. The further equipment includes an oxygen reviving apparatus.

THE Canadian Government has awarded the contract for the construction of Section No. 7 of the Welland Canal to the Canadian Dredging Company, which company has just completed Section No. 5. The new section extends from Port Colburne to Welland, taking in the Rainey Bend, which will be removed. The work will involve the removal of approximately 10,000,000 cubic yards of earth and 1,500,000 yards of rock, and the placing of a large amount of concrete. Five new bridges are to be built. The work will last for about five years.

ACCORDING to the *Mining Review*, Dr. A. Wade, who was commissioned by the Australian Commonwealth Government to report on the prospects of finding oil in the northern portions of Western Australia and the Northern Territory, has recently inspected those areas. He states that the area could not be less favourable, from the point of view of prospecting for, or for the finding of, petroleum supplies. It is more suited to the prospector for gold and other minerals, and there are now many such prospectors in that part of the country.

THE UNION STEAM SHIP COMPANY'S MOTOR LINER AORANGI

THE FAIRFIELD SHIPBUILDING AND ENGINEERING COMPANY, LIMITED, GOVAN, GLASGOW, BUILDERS AND ENGINEERS

(For description see page 23)

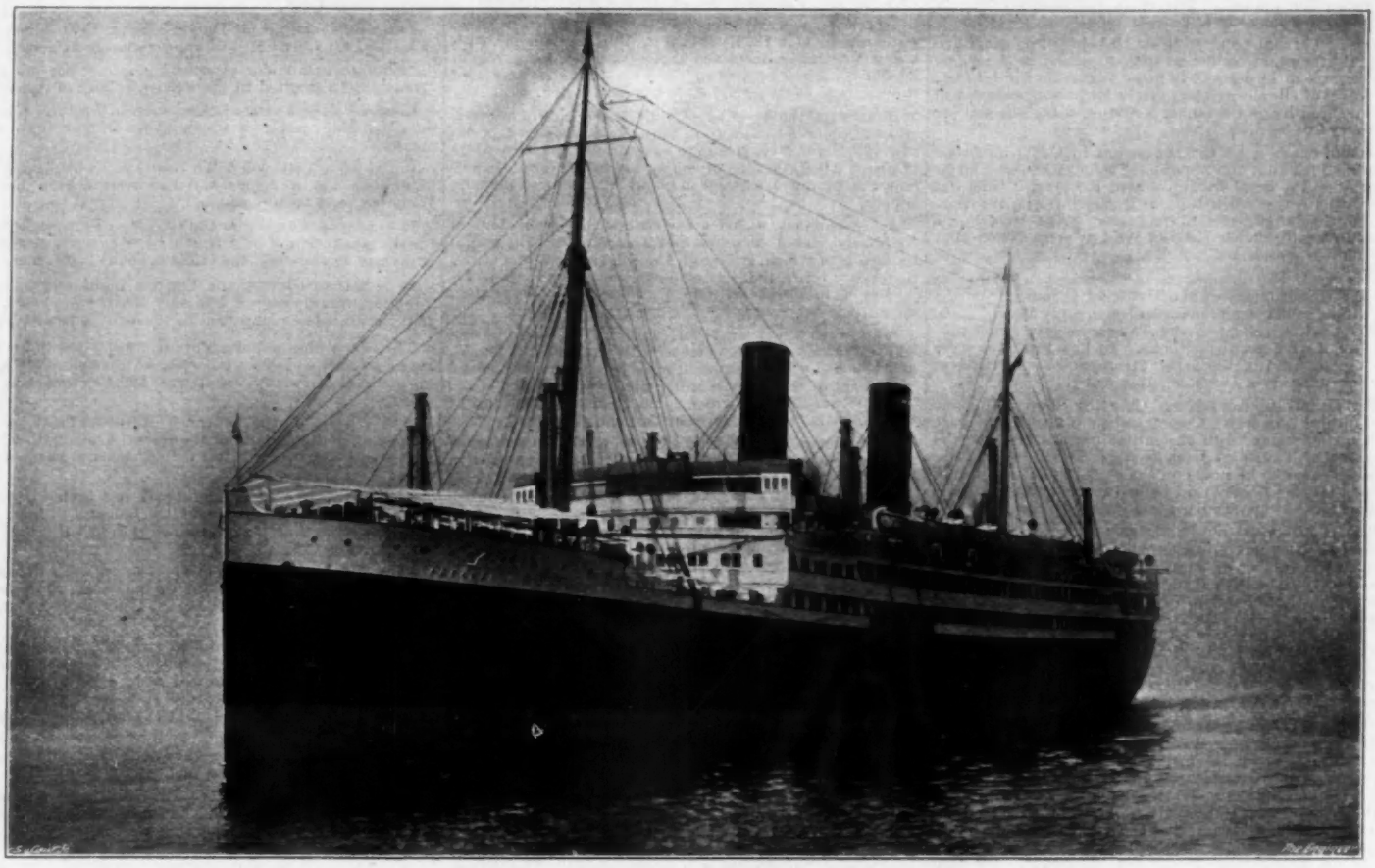


FIG. 1—VIEW OF THE SHIP TAKEN DURING THE CLYDE TRIALS

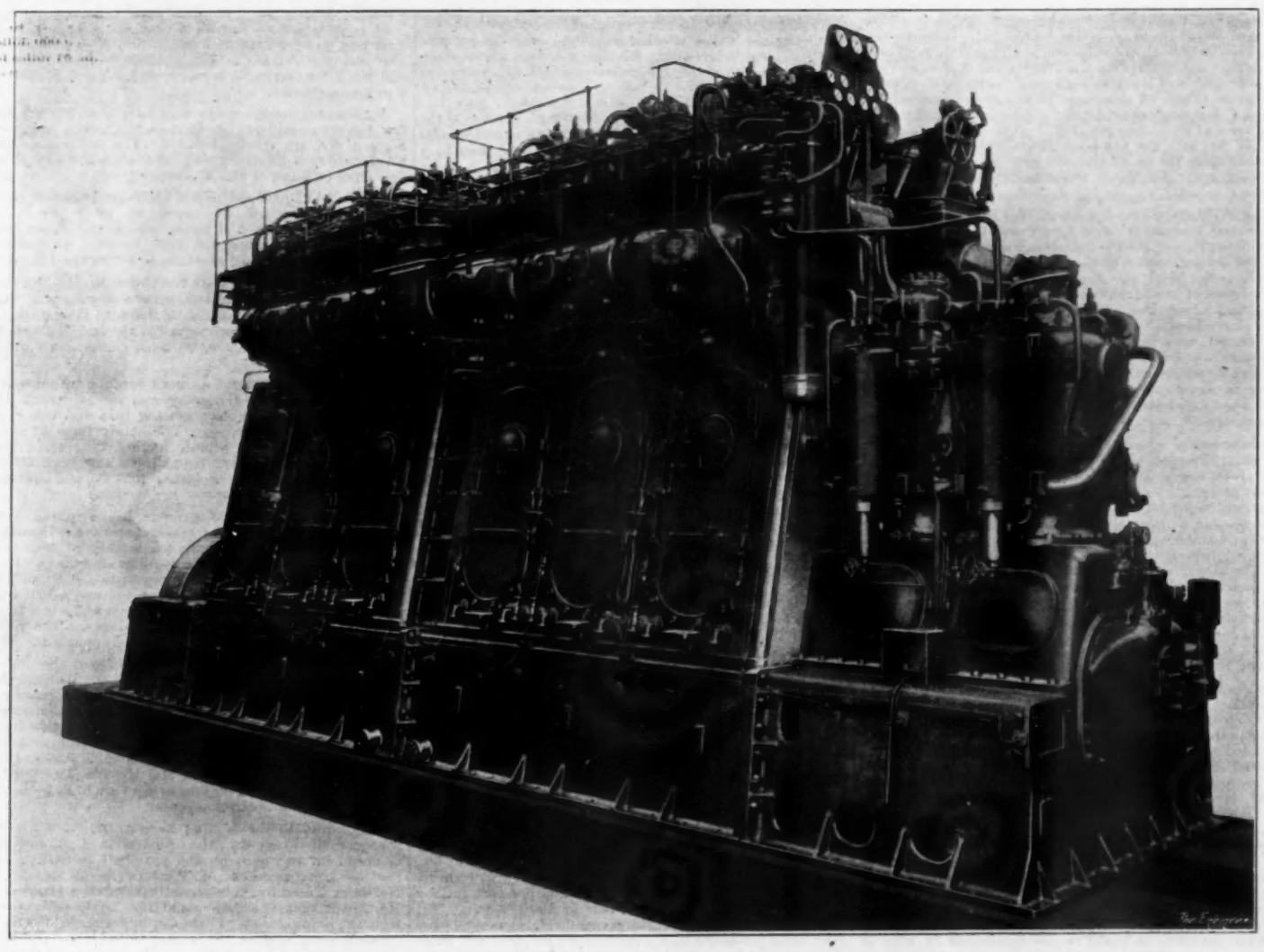


FIG. 2—ONE OF THE VESSEL'S FOUR MAIN PROPELLING ENGINES

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The Engineer

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EIGHT-PAGE SUPPLEMENT—LOCOMOTIVES, CIVIL ENGINEERING, LIGHT AEROPLANES, LINERS, MOTOR SHIPS, ELECTRICAL ENGINEERING, &c., IN 1924.

THE ENGINEER.

JANUARY 2, 1925.

1924.—A Retrospect.

NINETEEN twenty-four will be remembered as the year of the Empire Exhibition. That display of the interests and industries of the nations which compose the British Empire dominated more than the six months of the year during which it was open. Its coming attracted as much attention as its arrival, and its departure in financial gloom was a staple of conversation for several weeks, whilst up to the last minutes of the year the problem of its re-opening was still agitating the country. Financially it was a failure. The underwriters are called upon to meet half the sums they guaranteed, and we have yet to hear of any exhibitors who met even their out-of-pocket expenses. In many respects it was a thoroughly bad exhibition. It lacked that attractiveness and charm that a great stage manager like Imre Kiralfy knew so well how to impart. It had an air of vulgarity which could not but pain those who remembered all it stood for. Good and impressive in many of its parts, it was thrown together without any large artistic effect, and the pavilions, halls and palaces were connected by a road system which was the last word in badness and unsuitability. Moreover, the weather showed it its most spiteful face. Day after day it rained, turning the unmade paths into mud, and permeating the huge buildings with damp and gloom.

But despite its manifest defects it served a great purpose, and although for the time it leaves us heavily in debt, we must not hastily write it down a total failure. Of its educational value there can be no question; all sorts and conditions of men, women and children—the latter in vast numbers—saw in it things that otherwise they would never have seen, and received lessons in Empire resources which could have been given in no other way. It may be said with confidence that the British Empire knows now more about itself than it ever did, and that it has gained with that knowledge a greater self-respect and a greater belief in its future. That is one aspect, a rather intangible aspect, of the good it did. What ultimate value may reside in it none can say, yet all must feel an assurance that a wide and sounder knowledge of all of which the Empire is capable must in the end add new strands to the bonds which bind it together.

Another aspect is of a more material kind. Exhibitors lost their money indeed, but have they lost their pains? Let us speak only of the Palace of Engineering. The display of engineering in that great and uninteresting building came as a revelation to thousands of visitors from overseas. There was little in it that was novel, but there was a great deal, a very great deal, of sterling worth, and those who studied the exhibits with expert eyes were impressed with the soundness and extent of British engineering, and learnt for themselves how far from the truth is the assertion that the engineers of this country are decadent and indifferent. That knowledge which has gone to the far ends of the earth will have its repercussion. In time when orders begin to flow again more freely, Great Britain will not be so easily forgotten, and the superior patronage which the salesmen of other countries cultivate towards it will be set down to its real purpose. Furthermore, the Colonies, Dominions, and Protectorates, having seen what the old country can do, will exhibit a greater willingness to place their orders here. By what they did at Wembley British engineers paved the way towards a better Empire trade in the future.

As we have observed, the question of the re-opening of the Exhibition was agitated during the concluding months of the year. Let us say quite frankly that had the Exhibition proved a financial success the question of re-opening would never have been discussed. It has arisen, we believe, amongst those who hope that, since the bulk of the capital charges have been paid, some of the losses incurred by guarantors might be made good. Even now it is not definitely decided that the Exhibition shall re-open, and unless the support promised by other industries is greater than that which engineers feel inclined to give it will remain closed. But if it be decided to open the degrading little turnstiles again capital must be expended on improved roads and improved entrances, upon the removal of many unsightly features, and the provision of a hundred charms that will coax people from their homes to visit Wembley again and again. We have shown by the Exhibition of last year what the Empire can do; let us show by the Exhibition of this year that the Empire is not without dignity and not without some modicum of refined feeling.

Several notable meetings were held at the Exhibition, but none approached in importance the World Power Conference. At it representatives from all nations gathered together to discuss problems of power generation and power supply. It was the first of its kind and had certain manifest defects, but that it served a good end by bringing engineers from all parts of the world together cannot be questioned. It was originated and organised by the B.E.A.M.A., and although other institutions and societies gave their adherence, there was a feeling at its conclusion that it would be better if on future occasions the management were entrusted to an independent committee.

Labour.

It is with pleasure we record that labour troubles were less serious during 1924 than in the immediately preceding years. It is true that the disastrous shipyard dispute ran its course, but apart from it and a couple of transport strikes, there were no serious outbreaks.

It will be recalled that owing to disagreement over the Railway National Agreement of March 27th, 1919, an inquiry by the National Wages Board was opened under the presidency of Sir William Mackenzie, to hear arguments from both sides. Sittings began in November, 1923, and Sir William's award was published a few weeks later. The Associated Society of Locomotive Engineers and Firemen took exception to a clause in it which set the standard day for drivers at 150 miles, and since the railway companies felt themselves bound to accept the ruling, negotiations fell through, and at midnight on Sunday, January 20th, Mr. Bromley called out the members of his union. He was opposed in that action by the National Union of Railwaymen and the General Council of the Trades Union Congress, but, nevertheless, the strike proceeded, causing considerable dislocation of the railway services, although the men of the National Union remained loyal to their leaders. It continued until the early morning of Tuesday, January 29th, when an agreement was reached which provided that the basis of payment for mileage working should be 130 miles per day's pay from the date of operation of the decision until the beginning of the first pay week in July, 140 miles thereafter until the beginning of the first pay week in January, 1925, and 150 miles subsequently. The matter is of particular interest at this moment, as it is only within the last few days that a decision to retain 140 miles has been reached.

In February the Engineering and Shipbuilding Trades Union Federation advanced a claim for an all-round increase in wages of 10s. per week, and discussions took place with the Shipbuilding Employers' Federation concerning that demand.

Whilst these negotiations were proceeding, the shipyard workers at Southampton struck for an increase of 17s. 6d. per week, in order to bring the local wages into line with those in the Port of London. The position at once became very difficult, for the Southampton men refused to resume work on the instructions of the Federation of Engineering and Shipbuilding Trades Unions, and on its side the Shipbuilding Employers' Federation declined to discuss either the local or the national demands for advance in wages until peace had been restored. On March 26th a conference was held, but the Southampton men still remained recalcitrant, and the employers reported that nothing remained for them to do but to call a general lock-out in all federated yards. The lock-out notices were postponed from time to time in order to allow a settlement to be effected if possible, but no action proving of any avail, the lock-out came into force on April 11th, when it was estimated that 100,000 men were affected, but a week later work was resumed, pending a conference on the points at issue.

The second transport strike to which we have referred above occurred in June, when certain men who were dissatisfied with the attitude of the officials of the National Union of Railwaymen took independent action and sought certain increases of wages from the London Electric Railways and the Great Western Railway. The companies naturally declined to consider such irregular application, and the men thereupon called a strike, which began at midnight on Wednesday, June 4th. On the Great Western there was relatively little interference of traffic, but the Tubes and Underground Railways were seriously upset, and inconvenience to passengers was very considerable. The firm action of the Underground Railway authorities and of Mr. Cramp put an end to the strike, and caused the men to resume work on June 13th.

Many discussions on increases of wages took place during the year, but in no other case than those mentioned was there an outbreak of any importance, and it is significant that when the railway men's mileage came up for reconsideration during December, it was settled without trouble. We may perhaps attribute this diminished tendency to strike to the fact that the rate of unemployment in the engineering industries is still far above the normal.

Technical Progress.

With regard to the technical progress of the year there is but little to add to the full information given in many other pages of this issue. The only direction in which progress was remarkable was the increasing popularity of the internal combustion marine engine. From particulars given in an article on that subject, it will be seen that no less than forty-three ships were completed during the year, as against fourteen in 1923. It should also be observed that powers are mounting higher, and that the first great liner to be propelled by internal combustion engines, namely, the "Aorangi," was completed in December last. Much yet remains to be done before the marine oil engine reaches that state of perfection attained by the reciprocating steam engine and steam turbine, but there can be no manner of doubt that in the near future, and for ships of moderate power, it will become a more and more serious competitor of the older type. The principal direction in which improvements must be sought is in the lightening of the machinery weight for power developed. Sir George Goodwin showed in his admirable Thomas Hawksley Lecture to the Institution of Mechanical Engineers that the relative weights of complete steam machinery and of complete oil engine machinery were in the neighbourhood of 70 tons and 250 tons. It is probably too much to hope that engine for engine, the weight of the motor can ever be reduced to equality with that of the steam reciprocating engine, but engineers are confident that as knowledge of the working in actual practice of marine oil engines is gained, means of reducing the weight per horse-power will be found. In many cases, notably in that of the engines of the Sycamore, which were tested by the Marine Oil Engine Research Committee, the engineers preferred to make the motors exceptionally heavy rather than run the slightest risk of breakdown. When experience of the year-in-and-year-out working of the Sycamore has been secured, the designers will certainly see their way to lighten many of the parts, either by the reduction of scantlings or by the use of modified forms or different material.

In the last-named direction the metallurgist can be of the greatest help. Not only in internal combustion engineering, but in steam engineering too, the demands for a metal that will stand high temperatures without serious loss of strength and without distortion is increasing daily, and as more and more attention is being given to this subject, it is reasonable to hope that before long a material will be presented to engineers which will enable them to do things that they are now hindered from doing by the natural limitation of the known bronzes, iron, and steel. It is known that the Alloys Research Committee is turning its attention from non-ferrous to ferrous metals, and the thoroughness with which it carried out the former research, which culminated in the discovery of the alloy Y, inspires the belief that it will attain no less success in the research on which it is now making a beginning. Hitherto, the special alloys of all kinds, both ferrous and non-ferrous, have been debarred from common use by their excessive price, and it is to be hoped that the new metals may be less costly than the old. But it is not only in connection with the existing types of motors that the arrival of a new steel will effect a marked change. No notable progress of the internal combustion turbine was recorded during the year, but that does not mean that the subject is being neglected, and in more than one direction hopeful experiments are being carried out. In its case much depends on a heat-resistant metal.

In the domain of steam engineering, little of a remarkable character occurred, but reference must be made to the new thermal efficiency cycle which has been drawn up by the Heat Engine Trials Committee, and which was presented for discussion by Captain Riall Sankey at the Institution of Civil Engineers on December 11th. The object of the cycle is to modify the Rankine cycle in such a manner that it may meet the new conditions which are presented by the extending use of steam bleeding from turbines. So far it has met with but little criticism, and it remains to be seen whether it will be commonly adopted by engineers. It must, however, be remarked, as we pointed out in a leading article in our issue of December 19th, that it fails to exhibit the actual practical economies that can be secured by superheating, re-heating, and so on, and for that reason we may anticipate that it will not be popular with the commercial departments of steam turbine manufacturing concerns.

Whilst there were no marked developments in steam turbine practice during the year, the position of higher steam pressures and temperatures was strengthened, so that we may now safely regard pressures of 350 lb. as the standard for power station work in the near future, with the steam temperature not exceeding 750 deg. Fah. Pressures very much higher have, of course, been used, but they are still in the experimental stage, and they involve such difficult problems that they have little likelihood of becoming common for many years to come. In this matter, as in the case of internal combustion engines, it is to the metallurgist that engineers must look to enable developments to be effected. The limitation of steam temperatures to some 750 deg. Fah. is perhaps, for the moment, more serious than the limitation of pressure. If the use of greater pressures is desired, then it can be attained by the increase of scantlings, but in no such way can we overcome the temperature limitations which are imposed by available material. It is not only that steel and iron rapidly decrease in tensile strength and elasticity as the temperature rises, but that the materials used for valves and nozzles will not support the attacks of excessively hot steam. Alloys for valves are available, but who of the makers would care to see them continuously presented to a temperature exceeding 750 deg. Fah.?

Of the developments of locomotives during the year we speak in another page, and it is sufficient to express regret here that not one of the four great railway companies seems disposed to find money for the serious trial of totally new types of engines. One cannot but contrast their attitude with that of certain foreign railways which are finding the money for experiments. We would urge the four companies to unite in the formation of a considerable research fund which could be devoted to the manufacture and testing under service conditions of British-made and British-designed turbine and internal combustion locomotives. There is abundant evidence that in both directions success is in sight, and it will be a grievous thing indeed if Great Britain, the home of the locomotive engine, is not in the forefront of progress. Private manufacturers, notably the North British Locomotive Company, Limited, have done, and are doing, something in this direction, but the locomotive building trade is not in such a flourishing condition that it can afford costly experiments, and expenditure that would be trifling to the four railway companies in combination would be beyond contemplation by the locomotive firms.

The Conditions of Industry.

In conclusion, a few words must be said about the general conditions of industry during 1924. As a whole, trade showed a distinct tendency to improve, and by the autumn the electrical industries were enjoying a boom. Yet, on the whole, the year was not a good one, as such a valuable index as the output of iron and steel shows. The number of furnaces in blast at the beginning of the year was much smaller than in 1923, and fell from 204 in the beginning of January to 173 at the end of November. The average monthly make of pig iron was 855,000 tons in 1913; in January of last year it was only 636,600 tons; and it fell to 583,500 tons in November. Although more ingot steel was produced last year than in 1913, the growth in output was by no means proportionate to the expansion of productive capacity which the war brought about, and the monthly make declined by 20,000 tons between January and November. Whilst, on the one hand, exports were down as compared with 1913, on the other hand, imports were larger. Moreover, the prices of iron and steel goods fell throughout the year, in spite of a small but marked rise in the general price level.

Although all these factors are depressing, although foreign competition both at home and in overseas markets was and is very keen, and although the volume of orders from abroad is small and shows clearly a state of under-consumption, there is hope that the future will improve. The Dawes plan has materially contributed to the settlement of Europe. Confidence has revived and spread. Overseas markets have had some purchasing power restored to them by the recent rise in agricultural prices. Thus, the outlook is generally brighter, and as costs of production increase on the Continent and the large volume of latent demand makes itself felt, the iron and steel industries should benefit and should advance on the long, slow climb towards prosperity.

On the whole the engineering industry of this country underwent a very gradual improvement during the past year so far as the volume of trade is concerned; though, unfortunately, there is good reason to believe that prices on the average were too low to yield a satisfactory return. Estimated from the official returns for the first eleven months, our exports of machinery in 1924 amounted approximately to 463,000 tons, or 67 per cent. of the corresponding figure for 1913; whilst the average value per ton of exported machinery declined steadily from the 1921 peak to about twice its value in 1913.

There was during the year a gratifying increase in the proportion of exports to the British Empire overseas, which absorbed 52.8 per cent. of the total tonnage in 1924, as compared with 34 per cent. in 1913; but exports of textile machinery, the most important of our machinery exports, suffered a further drop and amounted to only 105,000 tons, as against 178,000 tons in 1913, and other instances of failure to show improvement in 1924 are afforded by machine tools, prime movers, boilers, and boiler-house plant. On the other hand, some improvement was shown in electrical machinery, the exports of which regained their pre-war level, and in agricultural machinery, though even now the exports of the latter are only 25 per cent. of the 1913 tonnage.

The slight improvement in the state of the industry during the past year was reflected in the unemployment statistics. At the beginning of the year the percentage of insured workpeople unemployed in the engineering trades was 18.3, whereas at the end of November the corresponding figure was 14.7.

Aeronautics in 1924.

To present any adequate account of the year's technical and scientific progress in aeronautics is nowadays an almost impossible task. With the exception of the light two-seater type of low-powered machine very few new commercial aeroplanes were produced during the past twelve months, and such as were did not illustrate any new or particularly interesting developments. To obtain a true measure of the progress made would involve a critical description of the service machines of the year. But in this region an impenetrable hedge of secrecy is rapidly growing up in all countries which precludes the publication, or even the mention, of any information con-

cerning current developments. Our own Air Ministry is noticeably forward in this respect, so much so that we are scarcely at liberty to deal freely with the design and construction of service machines less than four or five years old. To pretend that such machines represent current practice would be to endeavour to delude our readers. Judiciously restrained descriptions of service machines of a younger generation would convey little real knowledge concerning the intimate features in which the progress they mark really lies. Moreover, the more interesting of the machines open to this treatment were described and illustrated in our issue of a year ago, when the Air Ministry's control over what may and what may not be published was less strict than it has since become. As for the service machines born during the past year, it is not permissible so much as to whisper their fanciful alliterative names. From the national point of view we acquiesce in the situation, but from the journalistic standpoint it reduces our attempt to review the year's developments almost to a farce.

Light Aeroplanes.

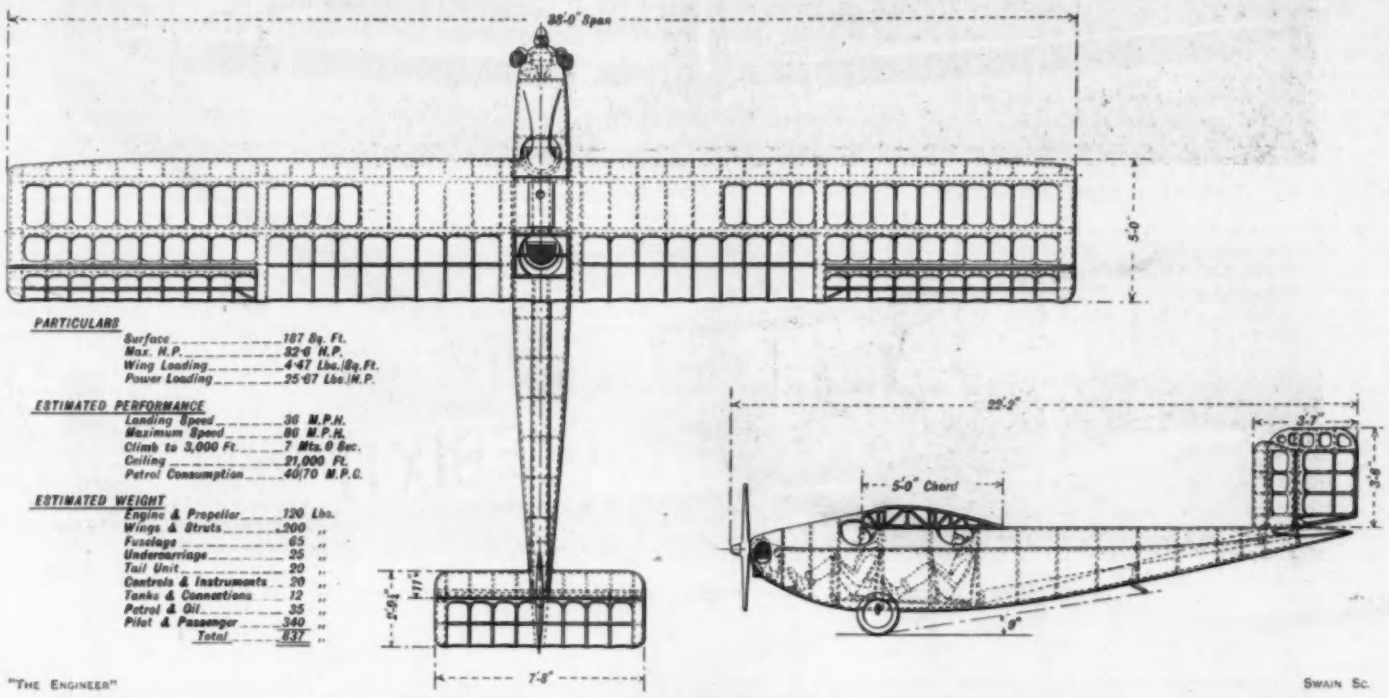
Whether we are on wholly safe grounds in dealing unrestrainedly with the development of the light aeroplane we are not quite certain. We may be so this year, but signs are visible that in the near future machines of this class will fall under the service category and not realise the destiny widely prophesied for them of becoming purely civil machines for the exclusive and extensive use of the civil population.

Following the "gliders" of 1922 and the glider type of machine fitted with a small petrol engine, which made its appearance in 1923, the past year witnessed the development of the two-seater light aeroplane. The advent of this class of machine was encouraged, if not inspired, by the Air Ministry's offer of a prize of £2000 in a competition open to two-seater, dual control aeroplanes with engines of not more than 1100 cubic centimetres cylinder capacity—that is, round about 25–35 horse-power. As will be seen from the Supplement, in which we reproduce views of certain of the machines designed for this competition, some of these aeroplanes show a fair degree of novelty in their general arrangement. Others, however, possibly the more mature designs, are little different in appearance from orthodox machines equipped with the extravagantly high-powered engines to which we have accustomed ourselves. There is no new principle involved either in their design or operation, and except for their size and power and the modifications in their constructional details which the reduction in these respects necessitates or permits, they may rightly be regarded as merely cheap miniature aeroplanes.

In their cheapness and their smallness, however, lies the chief reason for their development. As civil machines they undoubtedly bring flying—for those who wish to fly—within reasonable bounds of expenditure. From the service point of view their chief attraction lies in their use for training purposes, for, being cheap and easily flown by a pupil with an instructor as passenger, they provide a most useful step towards flight in a full-sized full-powered machine, while if a smash occurs the material damage done cannot be expensive to repair or replace.

The competition referred to, with the added attraction of extra prizes offered by certain private individuals, took place at Lympne at the beginning of October. About fourteen machines took part in it. For the first two days or so it threatened to prove a fiasco, but in the end it finished in an atmosphere of sustained interest, several of the machines succeeding in showing very creditable performances. The Air Ministry's prize was gained by the Beardmore Wee Bee monoplane fitted with a Bristol Cherub engine of 24 horse-power. This machine, illustrated in a Supplement flew a total distance during the trials of 737½ miles in a total time of 11 hours 54 minutes 41 seconds and attained a speed of 70.11 miles an hour during the high-speed test.

In addition to the view in the Supplement we give herewith a general arrangement drawing of Messrs. Beardmore's winning machine. It is of the thick wing monoplane type, but not of the cantilever form. The wings are formed on two box spars which are pin jointed to the fuselage and braced from below by two struts attached to the lower longerons. Except for these struts there is no external bracing anywhere, in the wings, the tail or the under-carriage. The wing spars and ribs are composed of spruce and plywood, and a covering of plywood 1 mm. thick is carried from the rear spar on the top surface, round the leading edge to the rear spar on the under surface. This construction provides all the drag bracing necessary. The fuselage is built on six spruce longerons with bulkheads of spruce and three-plywood and is



THE BEARDMORE "WEE BEE" TWO-SEATER LIGHT MONOPLANE

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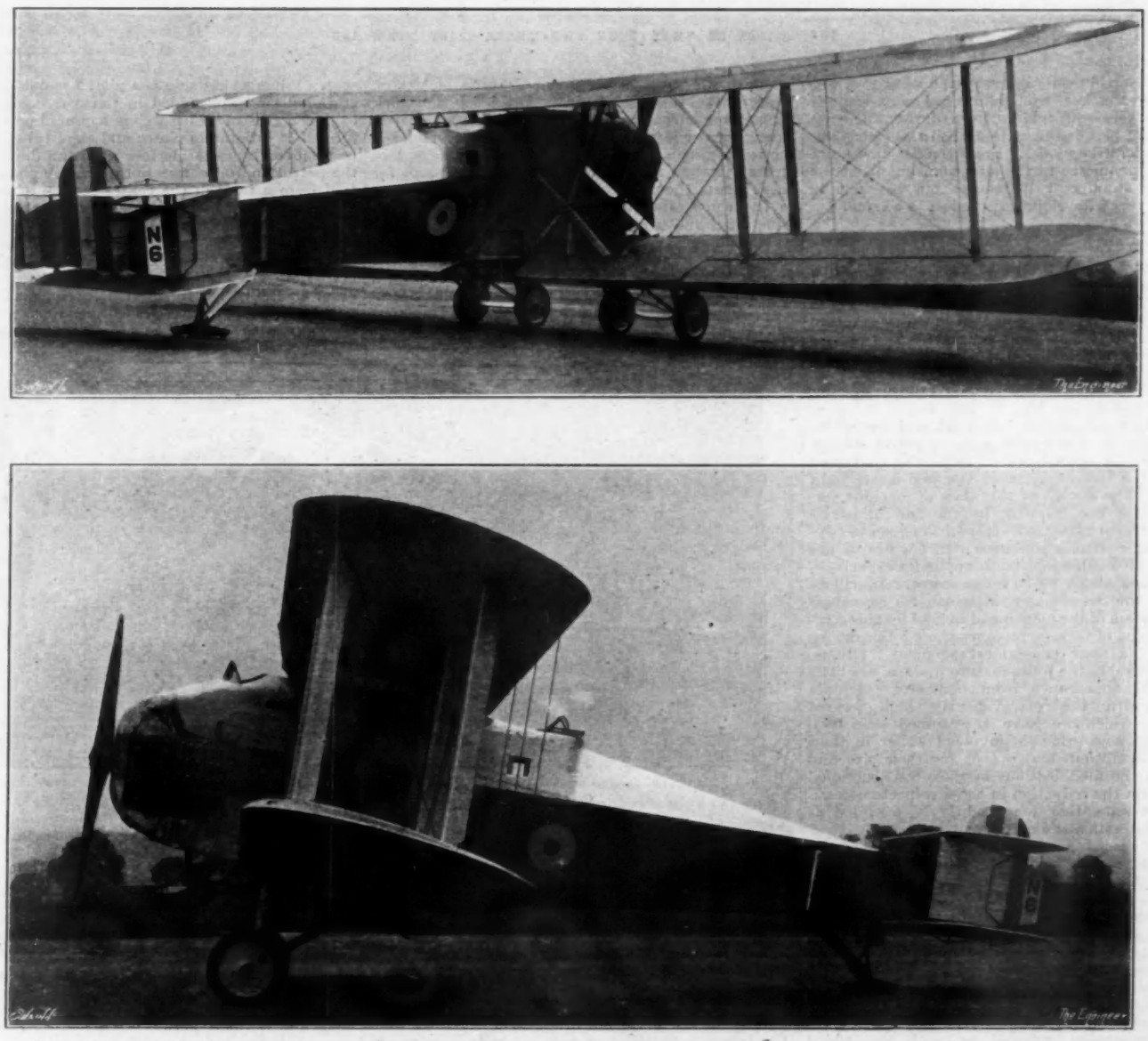
Passing to the other light aeroplanes illustrated in the Supplement, we have next the Gannet biplane designed and produced by the Gloucestershire Aircraft Company, Limited. Machines of this class, in order to fulfil their function properly, must be able to accommodate themselves within a narrow compass, not only with a view to storage in a small shed, but also to permit of their transportation along narrow country roads. The Gannet, like others, meets this requirement by the provision of facilities for folding its wings. A view of the machine in the folded condition is reproduced herewith. In order to reduce the overall width when the wings are folded, the hinges are placed near the middle ordinate of the wing cross-section. The trailing edges of the upper wings are thus caused to come close together, the rear portion of the central wing section being hinged upwards to permit the movement. The lower wings fold similarly beneath the fuselage. With the wings folded, the machine can be placed in an ordinary garage. The wing cross-section is of the "high lift"

THE GLOUCESTERSHIRE "GANNET" LIGHT BIPLANE—FOLDED

TWO AEROPLANES OF 1924

THE HANDLEY PAGE TRIPLE-ENGINED COMMERCIAL BIPLANE "HAMILTON"



THE BLACKBURN 1000 H.P. TORPEDOPLANE "CUBAROO"

type, giving a low landing speed, an increased command over the control, better manœuvring and other advantages. A gravity feed petrol tank, holding 2 gallons, without pumps or other apparatus likely to develop trouble, is fixed in the upper plane. The engine is a twin-cylinder inverted Blackburn of 649 c.cm. displacement, developing a maximum of 24 brake horse-power. The machine has a top speed of 72 miles per hour at ground level, a cruising speed of 64 miles and a landing speed of 35, a total weight of 460 lb., and a useful load of 168 lb. It should be noted that it is a single seater.

The two Westland machines were entered for the Lympne competitions by the Westland Aircraft Works, but were not primarily designed for the purpose. Competition efficiency associated with extreme lightness was sacrificed for substantial and durable construction. The Widgeon monoplane is a machine of the parasol type; that is to say, its wings are supported at some distance above the fuselage, and do not spring directly therefrom. In plan the wings have a somewhat unusual appearance, largely produced by the fact that the ailerons extend the full length of the trailing edge and are triangular in outline, with the apex near the middle of their length. There is no separate centre section in the wings, as in many other designs. The rear spars are shorter than the front spars, and are attached to a tubular structure springing from the fuselage. The front spars meet over the centre line of the fuselage, and are united by a small bolt. By freeing this bolt the wings can be folded back round hinges in line with the rear spar. In the act of folding the wings, the ailerons drop into a vertical position, and enable the wings to come close together. In the folded condition the overall width of the machine is 9ft. 9in. The engine is a three-cylinder radial Blackburn of 1100 c.cm. capacity, developing about 37 horse-power at 3700 revolutions. A supply of 4 gallons of petrol is carried in a tank in the nose of the machine just behind the engine. The fully loaded weight is 915 lb., of which 340 represent the useful load.

The Westland Wood Pigeon biplane, like the Widgeon monoplane, is a two-seater, provided with dual control. The wing arrangement is similar as regards the absence of a central section, and in the method of folding. In the folded condition the overall width is only 7ft. 6in., so that the machine can easily be housed in a garage or wheeled through an ordinary field gateway. The folding or unfolding operation can be completed by two men in ten or twelve minutes. The aileron arrangement is of interest, because all four of these organs can be raised or depressed simultaneously with the object of altering the contour of the wings, and so obtaining greater or less lift at any given air speed. This simultaneous adjustment of the ailerons is independent of their ordinary differential movement, and does not affect the full control of the machine as effected by such movement. Wood and fabric are employed in the construction of the machine in the usual way, duralumin being employed for the fittings. The undercarriage absorbs the landing shock by means of steel springs. In order to damp out the rebound, an adjustable friction device is provided, consisting of two telescopic tubes of oval section, with a lining of Ferodo between them. The engine is a Bristol "Cherub." The petrol tank, holding 4 gallons, is, as in the monoplane, carried in the nose of the fuselage, behind the engine. It is of interest to note that while the useful load, 340 lb., available for the pilot, passenger and luggage is the same as for the monoplane, the total weight fully loaded is 830 lb., or nearly 100 lb. less.

The Parnall Pixie III. monoplane produced by George Parnall and Co., of Bristol, forms an interesting contrast with the Westland monoplane and the Beardmore machine. In its case, the wings are attached to the lower longerons of the fuselage, and are stayed to the upper. They are arranged to fold, and can be readily supplemented by a second pair of wings, which convert the machine into a biplane. The folding of the wings is effected in a novel manner. The rear spars are pin-jointed to the fuselage. The front spars are connected by universal joints. With the rear spar connections freed, the wings can be tilted about the axes of the front spars until the trailing edges are uppermost, and then folded flat against the sides of the fuselage. At Lympne the machine was fitted with an Anzani engine of 1100 c.cm. capacity.

The sixth light aeroplane illustrated in our Supplement is a two-seater biplane, designed and constructed by the H. G. Hawker Engineering Company, Limited, of Kingston-on-Thames. This machine is distinguished by its low weight, the figure in the light condition being 373 lb., and loaded with the pilot, passenger, fuel and oil, 730 lb. The upper wings are attached to a centre section supported on four steel struts, and have a chord of 4ft. 3in. The lower wings are pinned to wing roots springing from the fuselage, and are of a much smaller size than the upper, the chord being only 2ft. 6in. The ailerons, as in the Westland biplane, extend the full length of the rear edges of all four wings, and, as in that machine, can be adjusted simultaneously without interfering with their normal controlling function. The fuselage has flat sides and bottom with a rounded top. One of the features of the construction, accounting no doubt for its lightness to some extent, is the fact that the fuselage longerons and struts are composed of wood, machined to a cruciform section, the junctions of the members being made by means of three-ply gussets, in place of the usual metal plate connections.

Among other examples of the light aeroplane class which may be mentioned, but with which limitations of space preclude our dealing, are the "Avis," of A. V. Roe and Co., Limited; the "Vagabond," of Vickers Limited; and the "Bluebird," of the Blackburn Aeroplane and Motor Company, Limited. These three machines are of the biplane type, and are all two-seaters fitted with dual control.

Some Civil and Military Machines.

Among the civil and military aeroplanes which may properly be allocated to the year, one of the most interesting is the Handley Page "Hamilton," of which we give two illustrations on page 20. In the design of this machine chief consideration has been given to the elimination of possible danger arising from engine failure. In general, the construction is similar to the firm's W 8 *b* type, which has been used for a considerable time on the cross-Channel routes, with the exception that three engines instead of two are employed. A Rolls-Royce "Eagle" engine of 360 horse-power is fitted in the nose of the fuselage, and a Siddeley "Puma" of 230 horse-power on each side of it. All three engines drive four-bladed propellers, the central one, however, being of larger diameter than the wing propellers. With this arrangement, it is claimed, the machine can continue to fly with any one engine out of action. Should both wing engines fail simultaneously—a very remote contingency—the central engine prolongs the glide to such an extent as to enable the machine to reach an intermediate aerodrome, even if it is fully loaded. The first machine of this type was built for the Belgian Air Navigation Company for use in the Belgian Congo, on a route of 1200 miles between Leopoldville and Elizabethville. That route passes over large dense forest areas, with only a few so-called aerodromes situated far apart, and is such that a breakdown or forced landing would almost essentially entail the complete loss of the machine. The journey will be performed in two days instead of forty-five as by surface transport. The machine carries twelve passengers, in addition to the pilot and a mechanic, and with 630 lb. of luggage weighs, in the fully loaded condition, 13,000 lb. Two petrol tanks, each with a capacity of 110 gallons, are fitted underneath the top wings. The maximum speed is 105 miles per hour, and the minimum landing speed 45. Slotted and balanced ailerons are used to obtain the maximum amount of lateral control. A "Hamilton" machine is now being used on the cross-Channel services by Imperial Airways, and will be put on the night-flying services which are about to be established.

The Blackburn "Cubaroo" torpedo-plane, produced by the Blackburn Aeroplane and Motor Company, Limited, is not properly a machine of 1924, except in so far that it was successfully tested during the past year. We illustrate it on page 20 because previously Air Ministry restrictions have prevented our doing so. The machine gets its peculiar title from the fact that it is a development of the firm's Kangaroo type of machine, and is fitted with a Napier "Cub" engine of 1000 horse-power. We are not allowed to say anything about its equipment or performance. It is intended to operate at long range on coastal defence work. It has a span of 92ft., a height of 22ft., and a length of 54ft. Its total weight is 9¼ tons.

The work of Vickers Limited was confined largely to a development of the commercial and service machines produced in 1923, and dealt with in our review of a year ago. This development work was particularly related to the Valparaiso two-seater fighting reconnaissance machine. On the commercial side, probably the most interesting, certainly the most historical, of the firm's productions was the Vulture amphibian, on which Squadron-Leader MacLaren made his courageous but unfortunate attempt to fly round the world. This machine, the actual one used in the attempt, is illustrated herewith.

THE VICKERS "VULTURE" AMPHIBIAN BIPLANE

It represents a development of the firm's original Viking amphibian, of which we have published descriptions on previous occasions. The chief features of the development consist of an improved form of hull bottom and a reduced loading on the wings. Fitted with a Napier "Lion" engine, the machine has a top speed of 100 miles per hour and a minimum speed of 49. It has a total weight of 7000 lb., of which 1816 lb. are available for paying load, in addition to 754 lb. for the pilot and the petrol and oil. In the fully loaded condition the wing loading amounts to 8.45 lb. per square foot.

The English Electric Company produced a number of large flying boats for the Air Ministry, fitted with two 450 horse-power Napier engines. The hull of these boats is approximately circular in section, with a planing bottom fitted on to form a double bottom. It is composed of an elm and mahogany framework, carrying a double skin of mahogany. A feature of the hull is a light dinghy, which is carried in an inverted position on the deck, and which forms part of the fairing. The firm devoted attention to the use of duralumin for the hulls of flying boats. Until recently the susceptibility of this material to corrosion in the presence of sea water has greatly restricted its use in seaplane work. It is now hoped to overcome this difficulty by using a protective varnish and by avoiding any contact of dissimilar metals that would give rise to serious electrolytic action. By the use of duralumin for flying boat hulls, it is hoped, among other results, to secure the elimination of water soakage which, with a wooden hull, may amount to as much as 400 lb. An electrical indicating device was patented and developed by the firm, whereby any leakage of water into the double bottom of a flying boat is made evident to the pilot by the glowing of a red light on the dashboard. The device consists of two electrodes in series with a battery and the lamp, the arrangement being such that the incoming water short-circuits the electrodes. Among

other experimental work conducted by the firm we may note the fact that the difficulties attendant upon the use of a hydraulic gear for adjusting the tail setting of aircraft when in flight have been satisfactorily overcome. On the commercial side the firm designed a twin-engined flying boat to carry ten, and a three-engined machine to carry 15 to 18 passengers.

The Fairey Aviation Company now employs 1500 hands, and during the past year was engaged on the production of five types of machine for the Air Ministry, including the "Fawn" and the "Flycatcher," illustrated in last year's review. In addition, it supplied machines to the Japanese, Portuguese, Swedish and Australian Governments. It extended and improved its shops and equipment, and reopened its Hamble works for the reconditioning of its own types of machine. It is now the company's practice to make check tests on the timber used for every spar in each machine built. For this purpose a test room has been fitted out, and, in addition, supplied with equipment for testing other materials. Of the new designs of machines undertaken by the company, little may be said beyond stating that two of them will be fitted with Curtiss D12 twin-six water-cooled engines, developing 450 horse-power. The British Empire rights for the manufacture of this famous engine have been acquired by the company. Other American patents have also been taken up, including those for the Curtiss surface radiators, the Curtiss system of engine temperature regulation, and the Reed solid duralumin air screw.

The De Havilland Aircraft Company, Limited, continued to manufacture the DH 9 and 9A types of military aircraft, the first-named being on occasion fitted with water-landing gear. In addition, on the service side, it produced certain experimental machines for the Air Ministry. On the commercial side, it concentrated chiefly on the DH 50 four-passenger machine, to which we referred in our review a year ago, and took the first steps towards the production of a new type, the DH 54, a sixteen-seater, to be driven by a 650 horse-power Rolls-Royce "Condor" engine. Similar steps have been taken in connection with a three-engined commercial machine.

The Bristol Aeroplane Company, Limited, like other firms, was engaged on confidential work for the Air Ministry. Among that work reference is permitted to the "Bloodhound," a two-seater reconnaissance and fighting machine embodying an all-metal system of construction, except as regards the wing, tail and fuselage coverings. We illustrated and briefly described this machine in our issue of July 11th, 1924. On the engine side the company continued to develop the three engines with which its name is associated—the "Jupiter," a static radial air-cooled engine of 400 horse-power; the "Lucifer," of 100 horse-power; and the "Cherub," of 22–34 horse-power. The "Jupiter" engine has been modified and improved in a variety of directions since the company took over its manufacture from its original designers, and is now being made under licence in France, Italy and Czecho-Slovakia. In the early part of the year the engine was tested by the Swedish Government at a point well within the Arctic Circle under severe and abnormal conditions. It behaved, we are informed, in a perfect manner. As a final test, it was left out all night in the open with the thermometer registering – 20 deg. Cent. In the morning it was started at the second swing of the propeller. Subsequently, it was flown for a distance of 1250 kiloms. in 6¼ hours, without a hitch. Prolonged tests of the engine in Egypt and Mesopotamia were carried out by the Air Ministry, with, it is understood, equally satisfactory results. By arrangement with Imperial Airways, Limited, a "Jupiter" engine was tested on the commercial route between Croydon and Cologne. On a heavy freight-carrying machine, it was run at over 90 per cent. full throttle for 150 hours without overhaul. Subsequently, it was stripped and all the parts were found to be in excellent condition. The 100 horse-power "Lucifer" engine was in use on six machines employed at the Bristol Flying School for the training of about 170 pupils. No case of forced landing through engine failure occurred, and no engine required even a top overhaul under 80 hours of running. The average consumptions of the engines during this period were found to be 5 gallons of petrol and ½ gallon of oil per flying hour. As regards the small "Cherub" engine—a description of the earliest form of which was given in our issue of March 9th, 1923—it is of interest to note that of the seven prizes offered in connection with the Light Aeroplane Competitions at Lympne in the autumn, six were gained by machines fitted with engines of this type.

Boulton and Paul, Limited, produced a new twin-engined day-bombing machine, the "Bugle," concerning which it is permissible to publish a few details. This machine is fitted with two "Jupiter" engines, and is of the biplane type, with tractor screws. Its wings have a span of 62ft. 6in., and a total area of 932 square feet; with a gross weight of 8760 lb., it has a useful load of 3681 lb., and a surface loading of 9.2 lb. per square foot. At ground level its speed is 120 miles per hour. It can climb to 10,000ft. in 15½ minutes, and to 15,000ft. in 39 minutes.

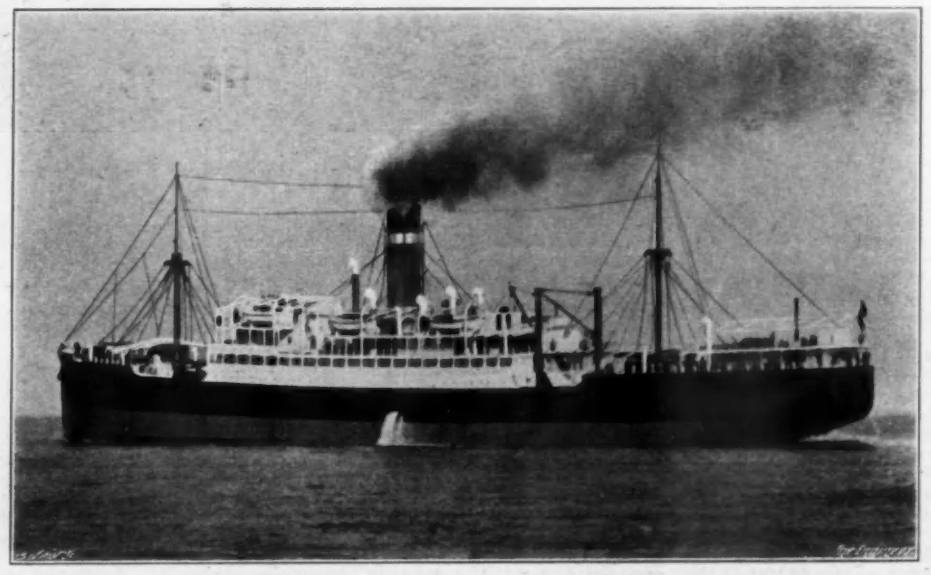
Airships.

The year witnessed a considerable revival of interest in the airship. After a prolonged period of delays and postponements, the German Zeppelin airship ZR 3, built at Friedrichshafen for surrender to the United States under the terms of the Peace Treaty, set out on her Transatlantic passage on October 12th. Following a route across France and Spain, she proceeded by way of the Azores to Nova Scotia, and thence to Lakehurst, New Jersey, where she arrived safely on October 15th. The total distance flown was just over 5000 miles. The time occupied on the trip was 81½ hours, giving an average speed of a little over 61 miles an hour. This airship does not properly belong to the year under review, for she was completed in all essentials in 1923, and was described in our issue of December 7th of that year. She is now known as "Los Angeles," and is attached to the United States Navy Department. In this country the year, so far as airships are concerned, was noteworthy by virtue of the fact that it saw the definite beginning of a Government scheme aiming at the encouragement of airship design and operation. During Mr. MacDonald's tenure of office it was officially intimated that the Government had decided to proceed with the construction of two airships, each of 5,000,000 cubic feet capacity, and to use them to develop a commercial airship service between this country and India. Preparations are now being made by the Air Ministry to build one of these vessels at the Cardington Works, near Bedford. This vessel will have a length of 720ft., and an overall height of 140ft. She will be propelled by seven 600 horse-power heavy oil engines, and will, it is estimated, attain a maximum speed of 70 miles an hour. Her gross lift will be 155 tons, of which 75 tons will be available for fuel, ballast, passengers, goods and stores. In her construction considerable use will be made of stainless steel. The second airship will not necessarily be of the same design. It is now being built at Howden by the Airship Guarantee Company, representing the Vickers, Shell-Mex, Burney group. In addition to the work thus outlined, the R 33, a sister ship of the Transatlantic airship R 34, is to be refitted and employed for research work.

Steamships of 1924.

THE year that has just passed will be remembered rather for its adverse conditions than for its prosperity, for the shipbuilding industry was not without its labour anxieties, whilst high taxation and large overhead costs, owing in many cases to yards not being fully occupied, contributed to the shipbuilders' difficulties. These causes affected particularly repairs and reconditioning, and not a few orders were lost to Great Britain owing to continental competition. In the closing weeks of the year hope was given by the grant to shipbuilding interests of access to the Trade Facilities Committee, but adverse effects were foreshadowed in wages increases demanded by the Boilermakers' Society and the plumbers.

Nevertheless there was considerable activity in most of the principal yards, whether on the Clyde, the North-East Coast, at Belfast, or at Birkenhead, and not a few ships, notable in the annals of British marine engineering and shipbuilding, were completed and placed in commission. Curiously enough, the Clyde output was a record one of 251 ships, representing over 538,000 gross tons, and machinery of close upon 450,000 indicated horse-power. The output was over three times that of last year, largely due to work which was held over from 1923 and launched early in 1924.



THE SINGLE-SCREW STEAMSHIP CITY OF VENICE—WORKMAN, CLARK

Some Liners of the Year.

In to-day's Supplement we illustrate three of the principal liners built during the year. The Atlantic Transport Company's 22,000-ton Minnetonka, which was launched at Harland and Wolff's Belfast yard early in January and underwent her trials in May, is a sister ship to the Minnewaska, engaged in the direct service between London and New York. She was fully described in THE ENGINEER of May 2nd. With her broad beam of 80ft. and her well-designed first-class accommodation, she is a deservedly favourite ship on the Atlantic route. Twin-screw Brown-Curtis geared turbines, with single reduction gearing, are installed. The auxiliary machinery of the latest type, both steam and electrically driven, is entirely independent of the main propelling machinery. Another Harland and Wolff-built liner of exceptional note was the Statendam for the Holland-America Line. This ship was not only the largest launched during the year, but also the largest built in a British shipyard since the war. Her principal dimensions are:—697ft. in length, 81ft. in breadth, with a depth of 53ft. 6in., and a total tonnage of approximately 30,000 gross. Unfortunately, she was not finished, but after launching was berthed at Belfast, there to await her owners' further instructions as to completion. Another liner launched, at Harland and Wolff's Greenock yard in October, was the P. and O. Company's 10,000-ton twin-screw steamship Rasmak, which is the eighty-ninth ship launched for the same owners from that yard. She was towed to Belfast for completion. Two other 15,000-ton liners, the Cathay and Comorin, were launched on the Clyde by Barclay, Curle and Co., Limited. Altogether the tonnage built by Harland and Wolff—including motor ships—amounted for the third year in succession to over 100,000 tons and machinery of over 86,000 indicated horse-power was constructed; that is a remarkable record having regard to the time of depression through which the shipbuilding industry passed.

Another prominent Atlantic liner of the year, which we illustrate to-day in a Supplement, is the intermediate twin-screw Cunard steamship Aurania. Swan, Hunter and Wigham Richardson, Limited, of Wallsend, built the hull, whilst her propelling machinery, of the Parsons turbine type with double-reduction gearing, was made by the Wallsend Slipway and Engineering Company, Limited, and is designed to propel the ship at a speed of 16 knots.

A large liner of the year, which we also illustrate to-day, the Orama, built by Vickers Limited, for the Orient Steam Navigation Company, Limited, represented an important step in the completion of the ambitious building programme of that company of shipowners. Following the practice adopted in the case of the Ormonde and Ormuz, only two classes of accommodation—first and third—are provided. The Orama, both as regards her passenger accommodation and machinery, is a remarkable addition to the company's fleet. In our issue of May 23rd we described her propelling machinery, which embodies a turbine arrangement novel as regards twin-screw practice. There are three turbines, a high-pressure, an intermediate, and a low-pressure unit on each set so that the three pinions, on the extended turbine shaft, engage with a common main gear wheel. A further feature of the machinery arrangement is the extended use of independent electrically-driven auxiliaries, and the use of 215 lb. pressure steam, superheated to 544 deg. Fah. The boilers are oil fired. Very remarkable results—quite comparable with best land turbine practice—were obtained during her trial runs in the Irish Sea and on the Clyde. On the low power trial a fuel oil consumption for all purposes of 0.924 lb. per shaft horse-power was obtained, while on the high power trial the figure reached was 0.785 lb. These results were certainly very gratifying, both to owners and builders, and the owners inform us that when in service similar economical running was maintained. A sister ship is to be built by Vickers for the

same owners. At the yard of John Brown and Co., Limited, Clydebank, the sister ship of the Orama, the Oronsay, was launched, and will be completed early in the present year. She differs little in design, but her propelling machinery is of the Brown-Curtis twin-screw type.

It is a little difficult in the short space at our disposal to give just due to the many intermediate and small ships which were built in British yards during the year. We illustrate the City of Oran Steamship Company's City of Venice—which was built at Belfast by Workman, Clark and Co., Limited. She is an 8700-ton ship, 470ft. in length, designed for cargo and passenger service, and is propelled by one set of quadruple-expansion balanced engines, constructed by the same builders.

Reconditioning and Repairing.

Undoubtedly the most interesting reconditioning job of the year was the complete overhauling and re-blading of the Mauretania's machinery at Southampton by John I. Thornycroft and Co., Limited. The blading material was supplied by the original builders of the turbines, the Wallsend Slipway and Engineering Co., Limited. In our issue of April 18th a special article described the process of truing-up the turbine rotors and casings in position. There was unfortunately some delay in the completion of the vessel, owing to the Southampton strike, and it became necessary to tow the giant liner to Cherbourg, where she was completed by Messrs. Thornycroft's skilled engineers with the assistance of French labour.

The performance of the Mauretania after her overhaul was a remarkable one, and some unusually fine runs were completed in August when the ship was on her Southern Atlantic course. At the end of August she made an eastbound voyage of 3157 miles in 5 days 3 hours 20 minutes at the record average speed of 25.60 knots, while on her westbound voyage an even better average speed of 26.25 knots taken over 5 days 1 hour 49 minutes was attained. During the year Messrs. Thornycroft carried out repairs on other Cunard ships, and the Carmania was reconditioned at John Brown's Clydebank yard. At Belfast Harland and Wolff repaired and reconditioned the White Star liners Olympic and Homeric—see THE ENGINEER of February 22nd—and the steamer Bardic, which was wrecked off the Lizard, was repaired. Another overhaul was that of the R.M.S.P. liner Araguaya. On the East Coast, Swan, Hunter and Wigham Richardson reconditioned the Spanish mail steamship Reina Victoria-Eugenia. At Dalmuir the Empress of France, the Canadian Pacific liner, underwent extensive repairs and was converted to oil burning by her builders, William Beardmore and Co., Limited.

Salvage Work and Shipbreaking.

Perhaps in a shipbuilding article some reference may be permitted to salvage work and shipbreaking of the year. Attention chiefly centred around the operations conducted at Scapa Flow by Cox and Danks, Limited, of Regent-street, London, in connection with the raising of six destroyers of the scuttled German fleet. The firm ingeniously made use of an old submarine floating dock, which was partially dismantled and cut in two. It was then equipped with hand-operated winches, to which wire ropes, passed under the vessel by divers, were attached. A view of the floating winch gear is reproduced in a Supplement to-day. The first destroyer, V 80, was raised early in July, and the five others followed at remarkably regular intervals. On the approach of winter Cox and Danks wisely suspended the work on further ships and concentrated upon the task of breaking up those raised, some of which were repaired sufficiently to allow them to be towed to Messrs. Thos. Ward's shipbreaking yard at Inverkeithing, on the Firth of Forth. Next year attention will be paid to the more difficult task of raising the Hindenburg and other battleships.

Railway Boats and Cross-Channel Steamers.

Two outstanding orders of the year were those placed with John Brown and Co., Limited, by the Canadian Pacific Railway for coasting steamers for its Pacific services. The Princess Kathleen and the Princess Marguerite, for so the boats are named, were almost completed during the year. They are 6100-ton ships with finely designed public rooms and sleeping accommodation for a large number of passengers. Brown-Curtis geared turbine machinery of 13,500 shaft horse-power capacity is fitted and gives the vessels a trial speed of 22½ and a service speed of 21 knots.

At the Dumbarton Yard of Denny Bros. and Co., Limited, two twin-screw, 321ft., 2292-ton cross-Channel boats, the Dinard and the St. Briac, were completed for the Southampton-Jersey service of the Southern Railway. The propelling machinery is of the Parsons single reduction geared type, and the ships are notable as being the first cross-Channel vessels to be fitted with oil-burning boilers. John I. Thornycroft and Co., Limited, completed a paddle steamer for the Isle of Wight service of the Southern Railway. William Beardmore and Co., Limited, built at Dalmuir two small railway boats for the L.M.S. Company's Goole service, the Hebble and Rye, whilst two other ships for this line were finished at Vickers' Barrow yard. They were the Dearne and Don respectively. In reviewing the events of the year reference must be made to the Harwich-Zeebrugge train ferry service, which was begun at the end of April, and has proved a valuable adjunct to rapid continental traffic. A description of the ferry steamers was given in THE ENGINEER of May 2nd.

Dredgers, Harbour and River Boats.

In an article published in our issue of December 19th we reviewed the recent trend of British dredger design and gave illustrations of recently built vessels. In the year that has passed several dredgers were built, but most of the yards specialising in this type of plant were but slackly employed. Early in the year the dipper dredger Lucayan, built by Lobnitz and Co., Limited, Renfrew, for the Bahama service of the Crown Agents for the Colonies, was placed in commission. The same firm delivered the Elderslie for the Clyde Navigation Trustees, which ship was specially designed for working in close proximity to quay walls. Five other non-propelling dredgers and six hopper barges were also delivered. At William Simons and Co's. yard at Renfrew, two important ships were the Ligon and Tigon, suction hopper dredgers built for the Anglo-Persian Oil Company's service at Basra. Two other bucket type dredgers were finished for British and colonial owners.

Fleming and Ferguson, Limited, of Paisley, delivered three dredgers and a hopper steamer and tug. They include a bucket and pump dredger for Argentine owners and a further bucket dredger for the Manchester Ship Canal Company, Limited, while a boulder bucket dredger was constructed for foreign owners. At Port-Glasgow, Ferguson Bros., Limited, completed a single-screw stationary gear-driven barge and loading suction dredger for the Port of London Authority, and a twin-screw grab hopper dredger, the M.S.C. Bollin. Five hopper barges were also completed.

During the year a number of tugs and barges for harbour work were finished and a notable share of this work was carried out on the South Coast. John I. Thornycroft built several tugs and two lightships, in addition to other vessels, whilst other tugs were completed at the Cowes yard of Samuel White and Co., Limited.

On the Clyde, Yarrow and Co., Limited, delivered two shallow river oil tankers for the Anglo-Saxon Petroleum Company, 206ft. long, the horse-power of each vessel being 3500. These boats are fitted with the latest type of Yarrow oil-burning boilers. It is interesting to record that hitherto vessels of this nature, being constructed only of very light scantlings, have been shipped in pieces and re-erected at their destination. But the vessels now referred to are to be steamed out to the East under their own power, and the first of them arrived safely in China in China late in the year. The second will leave the Clyde at an early date.

Higher Steam Pressures.

The competition of the internal-combustion engine has done much to introduce economies into steam vessels. Among new tendencies in modern marine practice we may enumerate higher steam pressures, higher superheat, and electrically-driven auxiliaries in the engine-room. The demand for higher-pressure marine boilers has led James Howden and Co., Limited, of Glasgow, to develop an improved type of marine boiler of which a test unit was built during the year and upon which exhaustive experiments are still to be carried out. It is of the cylindrical marine type, and can be fitted with furnaces up to five in number. To the cylindrical part a tubular economiser element is connected, which gives increased heating service, and at the same time serves as a feed heater. A forced draught system and a superheater of the regulating type may be fitted, and provision is made for both oil and coal firing. With the new design hand firing or mechanical stoking may be employed, and a new feature is the provision which is made for removing the ashes from the back of the boiler, thus facilitating the use of a mechanical stoker. The makers claim reduced space, lower cost, and a greater efficiency for this new type of marine boiler.

Steel of Controlled Elastic Limit for Shipbuilding.

One of the most interesting papers given at the spring meetings of the Institution of Naval Architects was that by Mr. A. T. Wall, Mr. G. W. Barr, and Mr. F. Grimshaw Martin, on a new high elastic limit steel. The discussion was particularly controversial. We are able, however, to say that during the year Scott's Shipbuilding and Engineering Company, Limited, began and will shortly launch a vessel of 420ft. length and proportionate dimensions, made of the steel then described. The ship was ordered by Alfred Holt and Co., and will be classed by Lloyd's Register and the British Corporation and will hold a Board of Trade certificate. We may emphasise the fact that the new material is not a high tensile steel. It is ordinary carbon steel of 28 to 30 tons tensile strength, manufactured under conditions which ensure that the true elastic limit—the limit of proportionality—is not less than 16 tons per square inch. The owners state that from their long experience—which is supported by the opinions of many experts in the matter—they have found that the usual elastic limit of ships' steel is in the region of 8 tons. It will be generally conceded that if a beam section or plate is stressed to such a point that it fails to return to its original shape it is virtually destroyed. The claim that the increase of elastic limit is of more value than an increase of ultimate tensile strength is therefore well justified. In this first ship it is proposed to economise only to the extent of, say, 10 per cent. of the weight of steel used in the ship, namely, 350 tons. This saving may, we learn, be largely exceeded if experience with the first ship is favourable. It may be stated that David Colville and Co., Limited, of Motherwell, made the steel, which was manufactured to the specification of Mr. F. Grimshaw Martin, Messrs. Holt and Co.'s metallurgist and chemist. We understand that its cost included a reasonably small extra charge for the special treatment of the material.

The Flettner Developments.

Anton Flettner is well known in shipping circles on account of the Flettner rudder, which was installed on the German motor ship Odenwald, and was described in our issue of June 22nd, 1923. During the year an improved type of Flettner rudder was introduced with three blades, and was fitted to three motor ships built by Krupps at Kiel for H. C. Horn and Co., of Flensburg. In the modified form of rudder the main rudder carries two arms, one on either side, to which side rudders, placed parallel to the main rudder, are attached. As in the case of the original rudder, the steering effect is obtained by moving an auxiliary rudder actuated from a light spindle placed within the hollow shaft of the main rudder. It is claimed that with a three-bladed rudder increased steering capacity up to an angle of 45 deg. to 50 deg. is obtained compared with 35 deg. for the single rudder.

An even more striking Flettner development is the rotor ship Buckau, which we illustrate in one of to-day's Supplements. In this ship sails are replaced by two rotating towers about 60ft. in height and 10ft. in diameter, which may be driven by electric motors at speeds up to 120 revolutions per minute. When the towers are rotated a propulsive force is communicated to the vessel by virtue of the Magnus effect, a name given to the action observed when a wind current is directed against a rotating body. By varying the speeds of rotation and the direction of rotation of the towers the magnitude of the force is altered.

In an article published in THE ENGINEER of November 21st, the Magnus effect was dealt with in a clear and simple manner. Herr Flettner's paper describing the ship, read before the German Institution of Naval Architects, was summarised in our issue of November 28th, whilst in a later issue, December 5th, simple means of demonstrating the effect were described. On Wednesday, December 3rd, a series of trials with the rotor ship Buckau were conducted in Kiel Harbour. A nautical correspondent contributed to THE ENGINEER a description of these trials, which was published in our issue of December 12th. We learn that Herr Flettner hopes to bring his ship to England in February, and to give a lecture on this new method of propulsion.

The Motor Liner Aorangi.

No. I.

THE departure of the quadruple screw motor liner Aorangi from Southampton to-day is a notable event in the history of British shipbuilding and shipowning. Leaving Southampton this magnificent mail and passenger liner will proceed *vid* the Panama Canal to Vancouver, British Columbia, where she will take up the regular service of the Union Steam Ship Company of New Zealand, connecting Vancouver, the Fiji Islands, and Honolulu with Auckland, New Zealand, and Sydney, New South Wales. It is of interest to note that the name Aorangi is the Maori name for Mount Cook in New Zealand, and a most appropriate one for a vessel engaged in the work of linking up our Colonies. Her builders, the Fairfield Shipbuilding and Engineering Company, Limited, of Govan, Glasgow, have constructed many fine ships both for the naval and mercantile services, but none, we think, finer than the Aorangi, which goes out to our Colonial Empire as an outstanding example of the best and most modern shipbuilding practice, combining the charm and grace of the British tradition in liner building with the most recent advance in propelling machinery design. Both owners and builders have the satisfaction of knowing that their initiative has been fully rewarded. During the last weeks of the year the Aorangi underwent sea trials lasting over a week with highly successful results, and the builders' guarantees as regards output of machinery and ship's speed were more than met. On the measured mile at Skelmorlie the total indicated horse-power, with the engines running at 125.4 revolutions per minute, was 15,500, corresponding to a brake horse-power, of 12,400, and the speed of the ship was 18.237 knots.

A 60 hours' trial was also run, during which time the vessel cruised in the Irish Sea, St. George's Channel and along the South Coast of Ireland to the Fastnet. Part of the time heavy weather was encountered, which, we learn, tested the machinery thoroughly, but both the engines and the ship behaved excellently.

A notable feature of the trials was the remarkable freedom from vibration. During this long trial the engines developed an average of 15,300 indicated horse-power, or 12,200 brake horse-power, at a speed of 123 revolutions per minute, and an average ship's speed of 17.91 knots was maintained. The fuel consumption of the main engines, calculated on the basis of pounds per brake horse-power hour, was, we are informed, 0.395 lb., and that of the auxiliary Diesel engines 0.036 lb. per brake horse-power of the main engines.

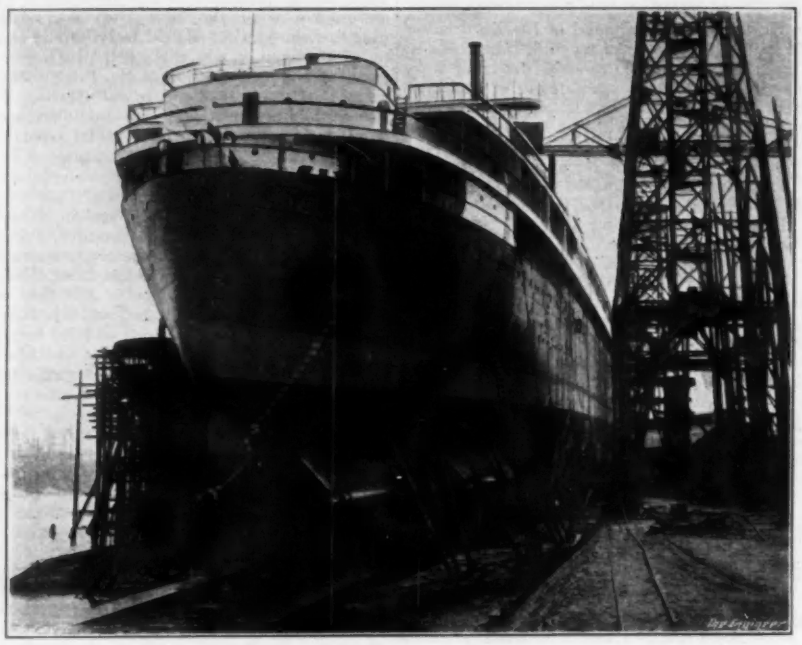


FIG. 3—STERN VIEW SHOWING PROPELLER SHAFTS

On page 16 we reproduce a bow view of the ship—Fig. 1—and an engraving—Fig. 2—showing one of her four six-cylinder Fairfield Sulzer engines, designed to develop 4500 indicated horse-power per shaft. The Aorangi is the first large four screw fast liner to be propelled by marine oil engines, and it is most appropriate that the Fairfield Company should be associated with the Union Steam Ship Company of New Zealand in this important development. Much credit is due to Mr. C. Holdsworth—the managing director of the Union Company—for the pioneer work which his courageous and progressive policy has made possible. In this respect, however, it may be recalled that this old-established Colonial line over which Mr. Holdsworth presides is noteworthy as one of the most progressive of British shipping companies. It owned sailing ships before the days of the steamship, and was among the earliest of shipowners to introduce such new features as triple screws and the water-tube boiler, which innovations were later followed by the steam turbine, the combined reciprocating and turbine arrangement, by geared turbines, and by oil fuel burning boilers. All these improvements have been surpassed by the company in the Aorangi, which holds the largest installation of two-stroke cycle Diesel machinery yet constructed.

THE DESIGN.

The order for the Aorangi was placed in the summer of 1922, and her keel was laid in the builders' yard at Govan towards the end of that year. At the time when the design was discussed, a total horse-power of about 3000 per shaft was considered to present no technical difficulties whatsoever. The Fairfield Shipbuilding and Engineering Company, Limited, had therefore no hesitation in putting forward a four-screw ship. Mr. Robert Traill, the engineering manager of the company, was responsible for the preparation of the design for the machinery installation, while Mr. W. T. Tucker, the superintending engineer of the Union Steam Ship Company of New Zealand, Limited, rendered valuable assistance. Messrs. Sulzer Brothers, of Winterthur, Switzerland, placed their unrivalled experience of oil engines at the disposal of the Fairfield Company, and in collaboration these firms have produced a Diesel installation which develops more than double the power of any marine set previously constructed.

The development of the Sulzer type of marine oil engine as we know it to-day may almost be said to be post war, and yet at the time of writing over forty-four cylinders of approximately the same dimensions as those of the Aorangi's engines are at sea and are giving, we learn, excellent results.

Before describing the ship, a few words may be said as to the benefit which a four-screw arrangement confers. A large engine-room casing, such as would have to be employed in a twin-screw arrangement, is entirely obviated by such a design, and much space above the water line, which in a liner is specially valuable, is set free for the purpose of public rooms. The designer of the Aorangi was thus enabled to make great improvements as regards the distribution of the accommodation space which are at once apparent to anyone who has visited the ship. From the point of view of the engineer a four-screw design permits the use of smaller and more efficient propellers, which may be housed well within the counter of the ship.

The sea trials of the Aorangi showed that the four propellers running at the moderate speed of 125 revolutions per minute, gave a high overall efficiency, and that the propulsive coefficient exceeded 0.58. This point may be illustrated by referring to the engraving—Fig. 3—which shows the vessel on her building berth before launching and permits the arrangement of the propeller shafts to be seen.

The machinery occupies the centre of the ship, the main propelling engines being placed slightly aft of 'midships, and the after funnel serves to house the four exhaust pipes. The auxiliary engine-room is forward of 'midships, with the two heating boilers so arranged that the forward funnel accommodates the exhaust pipes from four auxiliary engines and the uptakes from the two boilers and ventilating trunks.

Between the two engine-rooms the oil bunkeers are interposed. With the oil tanks in the ship's double bottom they carry sufficient oil for a voyage from Vancouver to Sydney and back, a distance of over 15,000 nautical miles, equal to about five trips across the Atlantic.

After these preliminary remarks some of the leading dimensions and particulars of the hull and machinery may be given :—

Hull Particulars.

Overall length	600ft.
Breadth	72ft.
Depth to lowest weather deck	46ft. 6in.
Gross tonnage	17,500 tons
Displacement	23,000 tons
General cargo space	225,000 cubic feet
Refrigerated cargo space	90,000 cubic feet

Designed Passenger Accommodation.

First class	440
Second class	330
Third class	230
Officers and crew	330 = 1330
Service speed	18 knots

Main Propelling Machinery.

Type : quadruple-screw, Fairfield-Sulzer, two-stroke single-acting motors

Number of cylinders per shaft	Six
Diameter of cylinders	27½in.
Stroke of cylinders	39in.
Normal piston speed	825ft. per minute
Total shaft horse-power	13,500
Total indicated horse-power	17,000
Normal speed of engines	127 revs. per min.

The general particulars here given indicate to some extent the interesting character of the vessel and her machinery. Referring to the illustration of the Aorangi—reproduced on page 16—the finely designed lines of the ship may be observed. She has a cruiser stern, and it is apparent that her general appearance has been studied by her designers, quite as closely as the details of equipment. The two raked funnels are well placed and, together with the poled masts, give the ship a particularly stately form. Her appearance is perhaps added to by the pleasing superstructures, the high bridge and well arranged boat deck. A view of the boat deck is given in Fig. 4. Not a little charm is lent also by the neat way in which the ship's boats have been stowed. The davits are of a new kind and represent the latest practice in boat launching equipment. They are of the MacLachlan automatic type, supplied by the MacLachlan Automatic Boat Davit Company Limited, of Glasgow. By means of specially shaped davits, gravity is used to swing out and lower the boats, which can be placed in the water within a few seconds. Electrically operated motor winches are employed to lift the boats back to their stations. When in position they are retained by a safety catch, the release of which serves to launch them.

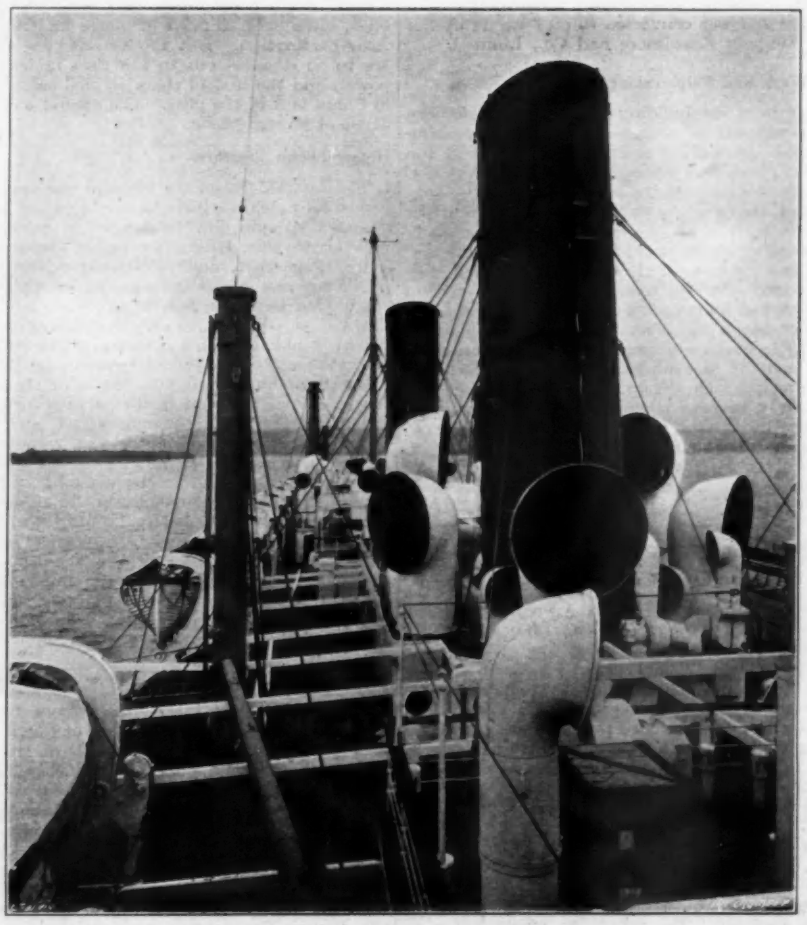


FIG. 4—BOAT DECK LOOKING AFT

Sanitary Engineering in 1924.

No. I.

IT can, we think, at last be said that the tide in certain aspects of engineering work has definitely turned. For ten years or so, now, matters which, a decade ago, urgently required attention, have had perforce to be neglected. Now, however, there are many signs which indicate that an advance towards normal conditions has begun. It is only natural that such necessary questions as the proper disposal of sewage should, when it again became possible to carry out works, be among the first to receive attention, and it is not surprising therefore to find that numerous schemes were introduced during the year which has just closed. On some of them, constructional operations were actually commenced during the period under review, and they, taken in conjunction with those which were already in progress twelve months, make up a not inconsiderable total. So numerous, in fact, are the proposals that have been brought forward, or are in course of being effected, that it will be quite impossible for us to refer to all of them. It must suffice to mention a few of the more interesting. Among the most important, in point of magnitude, at any rate, are the main drainage works which have now been under construction in the Metropolis for some years.

London Main Drainage.

Considerable progress was made with the comprehensive scheme of works for the relief of flooding in the area under the control of the London County Council. The total cost of these works was, on a pre-war basis, estimated at £2,500,000. The following were under construction during the year :—

North-Eastern Storm Relief Sewer.—This sewer, which is about 4 miles in length, was designed for the relief of flooding in the north-eastern portions of the county. For the first 2½ miles it is built of brick, and varies in diameter from 8ft. to 9ft. For the remaining distance it is 11ft. 4in. in diameter, and is constructed of cast iron lined with concrete. The outlet into the river Thames is at Shadwell. The sewer, which was built in tunnel throughout, was completed and put into service.

Hammersmith Pumping Station.—The new storm water pumping station for relieving the sewers in the low-lying parts of Kensington and Hammersmith was nearly completed. The gross pumping capacity of the machinery with which it is being equipped is 1000 tons of storm water per minute.

South-Western Storm Relief Sewer.—This sewer is intended to relieve the Effra sewer at Brixton, as well as other important sewers, and to discharge storm water into the river Thames at Nine Elms. The whole of the sewer, which will be about 2¾ miles in length, is to be in tunnel, the greater part of it being lined with cast iron and concrete. The major portion of the tunnelling work was completed.

Streatham Hill Sewer.—This sewer is designed to relieve floodings in certain parts of Streatham and Brixton. It will be of brick, nearly 1½ miles long and 4ft. internal diameter along Streatham Hill and Brixton Hill, where it will connect with the South-Western relief sewer. Good progress was made during the year.

Lewisham Branch Sewer.—This sewer, the purpose of which is to relieve floodings in Lewisham and the neighbourhood, will run from Bell Green, Lower Sydenham, to a junction with the Southern High-level Sewer No. 2, near Court Hill-road, Lewisham. There is also to be a branch from Catford Station. The total length of these sewers will be approximately 3 miles. Their internal diameters will vary from 5ft. to 9ft., and they will be principally in tunnel in brickwork. Good progress was made with them during the year.

Eltham Sewer.—This sewer, which will run from Eltham-road, near Eltham Green, to make junction with the Southern High-level Sewer No. 2 at Charlton, is intended to relieve floodings in Eltham, Kidbroke, Greenwich and Woolwich. It will have a length of about 2½ miles, will have an internal diameter of 8ft., will be principally in tunnel, and will be partly in brickwork and partly iron lined. The work is well in hand.

Sludge Steamers.—Two new steamers of 1500 tons capacity each were delivered by Vickers Limited to replace older vessels of 1000 tons capacity, and are now engaged in the work of conveying sewage sludge to sea.

Manchester Main Drainage Scheme.

The work in connection with the main drainage scheme of Manchester was in full progress during the year. Work No. 4 comprises a barrel sewer in brickwork 12ft. internal diameter, nearly two miles in length, running from Upper Moss-lane to Great Ancoats-street. The work is in tunnel throughout and the depth varies between 34ft. and 83ft. below the surface. The ground tunnelled through is chiefly in the red sandstone formation. This work, which is being carried out by contractors, is approaching completion. Work No. 5 comprises a length of sewer between Adair-street, Great Ancoats-street, where it will make junction with Work No. 4, and Blackley, *viâ* Great Ancoats-street, Swan-street, and Rochdale-road, Angel-street and Fitzgeorge-street. The total length is four miles, and the diameters range from 12ft. to 4¾ft. It is constructed in brickwork, except for a length which will be lined with cast iron segments, where the ground is expected to be in running sand. This work is also in tunnel at depths varying from 70ft. to 141½ft., and will take about three years to complete by contract. The number of men employed on the two contracts, Works Nos. 4 and 5, is about 400, including the night shifts.

Leeds.

The extensive new sewerage works at Leeds have proceeded steadily during the year, as have also constructional operations at the disposal works at Thorpe Stapleton. The original estimated cost of this scheme, as authorised by the Act of 1908, was £1,277,000, divided into £208,000 for new sewers, and £1,069,000 for the disposal works. By a further Act obtained last year, the expenditure of an additional sum of £851,000 was sanctioned, the revised estimated total cost of the scheme being now £2,128,000. The present dry weather flow is 17½ million gallons per day, and the expenditure referred to will, it is estimated, meet all requirements for an additional dry weather flow of 3¾ million gallons. During the year a further length of 1 mile 46 yards of new high-level intercepting sewers was driven and completed at a cost of about £75,000, making a total length of four miles of sewer completed, and leaving four miles still to be constructed. At the disposal works an area of about 9 acres of percolating filters was completed, making 21 acres now in service. Operations were also started on the construction of a further 15 acres, which, it is anticipated, will be finished during the present year. The medium employed is principally washed gravel dredged from deposits of glacial drifts in the bottom of the valley of the river Aire, the gravel varying from 1in. to 3in. screened size. The beds are rectangular in form, and in the completed installation the distributors for about half the area will be power driven by electic motors, while those on the other half will be operated by water wheels actuated by the head of tank-effluent. Good progress was made during the year on the special foundations required for the low-level sewage precipitation tanks, which involved unforeseen and exceptional difficulties in consequence of a large bed of silt or sand, of a depth of about 12ft., overlying a bed of gravel communicating with the bed of the river Aire, having been encountered at the constructional level of the floors of the tanks, which have an area of about 3 acres. To meet the difficulty reinforced concrete cylinders, 9ft. in diameter, were made in sections on the site, and sunk down to the level of the gravel bed through the water bearing sand or silt by a special machine. The interiors of the cylinders, the construction and sinking of which will be completed in some three months, are being pumped or dug out and filled in solid with concrete to the level of the proposed tank floors, and strong reinforcements are being built into the cylinders to provide anchorage for the reinforced concrete floors of the tanks.

Two Thames-side Sewage Works.

Two sewage disposal schemes, both of them to the east of London, and both on the north side of the Thames, were brought to a satisfactory completion during the year. They are that of the Thurrock, Grays and Tilbury Joint Sewerage Board, the disposal works of which are near Tilbury Station, and that of the Romford Rural District Council, the disposal works of which are near Rainham. These two schemes are similar in that they both embody long lengths of intercepting sewers and that the effluents from both are discharged into the Thames. Furthermore, there was similarity in that in both cases very considerable difficulties occasioned entirely by the extraordinary character of the ground traversed by the sewers, and of that of the sites on which the disposal works were built, were experienced and satisfactorily overcome. At Tilbury the disposal works are designed to treat a dry weather flow of 1,650,000 gallons in twenty-four hours, and can deal with a maximum flow of 10,000,000 gallons per day. The station is equipped with oil engine-driven electric generators and with electrically operated centrifugal pumps. The sewage is lifted into sedimentation tanks, the effluent gravitating to revolving sprinkler beds and thence through humus tanks to the outfall. It is therefore in a highly purified condition when it is discharged into the river. The pumps at the riverside works near Rainham are driven direct by heavy oil engines. One unit can lift 1500 gallons per minute —or 2,160,000 gallons per day—against a head of 28ft., and there are two other units, each capable of dealing with double that volume. The total capacity of the pumps is therefore 10,810,000 gallons in twenty-four hours. The sewage is delivered by the pumps into two conically shaped depositing tanks, the effluent from which passes to sedimentation tanks, of which at present there are four. The effluent from these tanks is discharged direct into Rainham Creek down which it finds its way into the Thames. As the tanks are tide-locked during certain periods of the day, two tidal storage tanks—see Supplement—have been provided to contain the final effluent when the tides do not permit of it being discharged into the creek. At both works there are, of course, the necessary arrangements for screening the sewage as it enters the works and for separating, lifting and drying the sludge.

New Sewage Pumping Station at Lincoln.

On the last day of March a new sewage pumping station at Lincoln was formally put into service. The present volume of sewage dealt with at Lincoln varies between two and two and a-quarter million gallons per day in dry weather to over nine million gallons per day in times of heavy rainfall. It was decided when getting out the plans for the new pumping station to install machinery which should not only be ample to meet present requirements but which would also provide a handsome margin to meet any demands which might be made upon it for a number of years ahead. Accordingly, five separate units were put in, the first three of which are three-throw ram pumps driven by uniflow steam engines, while the other two are motor-driven centrifugal pumps. The three ram pumps have capacities of 1,500,000, 3,000,000 and 4,500,000 gallons per day respectively, and are, therefore, together capable of dealing with three times a dry weather flow of 3,000,000 gallons per day, and delivering it to the treatment works. Each of the centrifugal pumps can lift 9,000,000 gallons per day against a head from all causes of 18ft., and they deliver into three specially built storm water tanks which have a combined capacity of 750,000 gallons. The scheme embodied the carrying out of a number of subsidiary works, including the laying of a new relief sewer about a mile long. Considerable difficulties were presented by shifting sand which was encountered in the foundations and trenches, and of the nearness to the surface of the standing water level. An interesting feature of the scheme is that a large proportion of the steam required for working the engines is furnished by boilers fired with refuse in a destructor house near which the pumping station stands.

New Disposal Works at Newark.

New disposal works for treating the sewage of Newark were opened in November. The present population of the borough is 17,000, but the works have been designed to deal with the sewage produced by 20,000 persons, the daily dry-weather flow being taken at 400,000 gallons for the domestic sewage, with an extra 100,000 gallons for trade waste, which comes for the most part from breweries. The wet-weather flow is taken at 3,000,000 gallons per day. The works comprise intercepting sewers, varying in diameter between 21in. and 30in. A considerable amount of difficulty was met with in constructing these sewers in ground below the level of the river Trent, but they were overcome and the work, when completed, was found to be absolutely watertight. The sewage arrives at the pumping station, 10ft. below ground level, and enters a storage tank capable of holding 38,500 gallons. This tank is carried down below standing water level, and special precautions had to be taken to anchor it down and to prevent water entering it. The pumping station contains two 38 brake horse-power crude oil engines, each of which drives a 24-kilowatt electric generator, the current produced by which is used not only for working the pumps but also for driving the screening, dredging and sewage agitating machinery. There are two 7in. and two 6in. low-lift centrifugal pumps, the larger pumps, each having a capacity of 40,000 gallons per hour and the smaller pumps a capacity of 25,000 gallons per hour each. The pumping plant is arranged in two units, each unit consisting of a 6in. and a 7in. pump coupled together, and driven by one motor. The two pumps working together are capable of dealing with three times the dry-weather flow, or 1,500,000 gallons per day. For sludge pumping there are two 4in. low-lift centrifugal pumps, each capable of lifting 12,000 gallons per hour. The disposal site consists of 22 acres. The process of purification includes treatment in Dortmund preliminary settling tanks, followed by treatment in large Dortmund tanks by mechanical surface tension agitators. The effluent from the tanks passes to two Dortmund settling tanks, and is discharged over an aërating weir of special form into the Trent.

Electrical Engineering in 1924.

No. I.

IF there is one point that should be emphasised more than another in this review of electrical engineering, it is that during the period under consideration there was a certain amount of technical progress. Every year the electrical manufacturers carry out a considerable quantity of important work, but for the most part it is of an orthodox and familiar character, and does not call for special comment. While nothing very revolutionary was done by the electrical firms during 1924, there was, nevertheless, a tendency in certain quarters to break away from conventional ideas, and to adopt new methods. Whether we all agree with certain schemes that were put forward during the last twelve months does not very much matter. All attempts to strike out on

new lines are, in our opinion, praiseworthy, quite apart from the question of whether the particular proposal is universally accepted or not. In some respects electrical practice has undergone very little change since the days when electricity was first brought into use, and those who try to improve on existing methods deserve every encouragement. Mr. Verebely's new system of railway electrification was, of course, one of the principal electrical developments. Another was Mr. W. E. Highfield's transverter, which is a machine for converting alternating current into high-pressure direct current for transmission purposes.

The conversion of alternating current into direct current at high and relatively low pressures received, and is still receiving, considerable attention. The thermionic rectifier, which is believed by many to be capable of dealing with very much larger powers than those with which it deals at present, is giving rise to investigations which may ultimately have a very marked effect on electrical practice. Static converting apparatus is bound, in our opinion, to come into general use in the future. Already very fair progress has been made in that direction, the latest application of apparatus of this class being at Birmingham, where glass bulb mercury vapour rectifiers are used for giving a direct-current supply to the outlying districts. In the cable manufacturing industry there was progress in the direction of producing cables for higher pressures and 66,000-volt three-core cables were constructed. Considerably higher pressures can, of course, be adopted if three single core cables are used; a scheme which will no doubt come more into vogue in the future. Whilst speaking of cables, it is fitting to remark that one of the large cable manufacturers, namely, W. T. Henleys Limited, started up a very fine research laboratory, which we described in the issue for November 28th last, and which we illustrate in part in Figs. 1 and 2.

The display of electrical machinery and apparatus in the Palace of Engineering at the British Empire Exhibition was a truly remarkable one from the point of view of magnitude and general excellence, but it was not nearly so remarkable as regards novelty. The most original exhibits, apart from the transverter, were the automatic equipments for controlling rotary converters, &c., in order to cut down the working expenses in sub-stations. In the lighter branches of the electrical industry much interesting work was done, especially in the wireless branch, which is dealt with in another part of this article. The transmission of photographs by "wireless" from London to America was perhaps the most wonderful achievement of the year. The investigations of Dr. T. E. Wall, of the Sheffield University, in connection with the production of very intense magnetic fields was another event that should be recorded.

Wireless Communication.

Mr. Marconi's short-wave experiments, which he described in papers read before the Royal Society of Arts, see THE ENGINEER Aug. 29th and Dec. 19th, 1924, came as a revelation to many wireless experts. The original opinion that short waves were unsuitable for long distance transmission was completely upset by these experiments, which were undertaken with a view to finding an explanation for freak results and with the object of ascertaining whether by means of short waves it would be possible to use a long distance directional system. During the experiments methods were developed for generating short waves on a more powerful scale than hitherto, and of concentrating the radiation in any desired direction. It was found that under certain conditions concentrated transmission with short wave lengths can be relied upon to give satisfactory results in the daytime as well as at night. It is said, in fact, that it has been abundantly proved that reliable communication by this method can be maintained throughout the 24 hours over distances of 12,000 miles. An important advantage of this short wave reflector system is that only a fraction of the power that is required with the longer wave system is necessary.

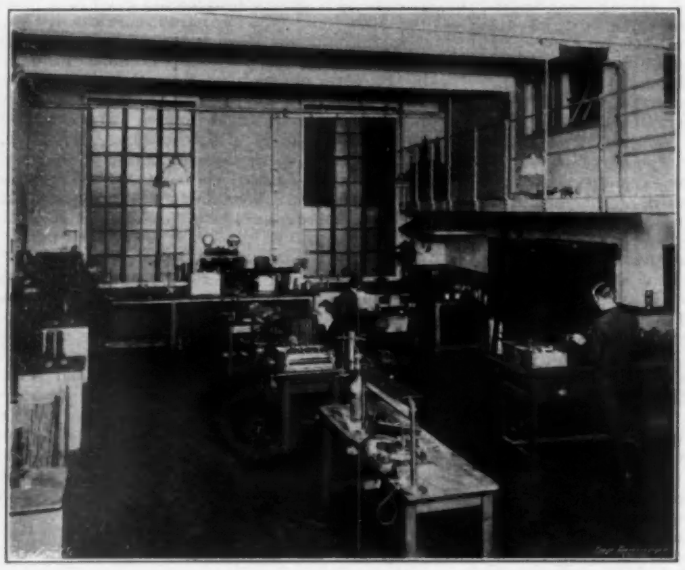
Another interesting and important result is that much higher speeds of signalling are possible. Interference from atmospheric disturbances is, to a very large extent, overcome, and mutual interference between various long distance stations scattered in different parts of the world is practically avoided by the adoption of this short wave reflector system. Stations designed to work in accordance with this new scheme are being erected in England, India, South Africa and Canada. These stations should be in commercial operation before the end of this year, and when the new channels of communication are open the traffic-carrying capacity of the Empire communication system will be considerably augmented, and the charges for telegraphic traffic substantially reduced. Probably some of these channels will be available for telephonic as well as telegraphic traffic.

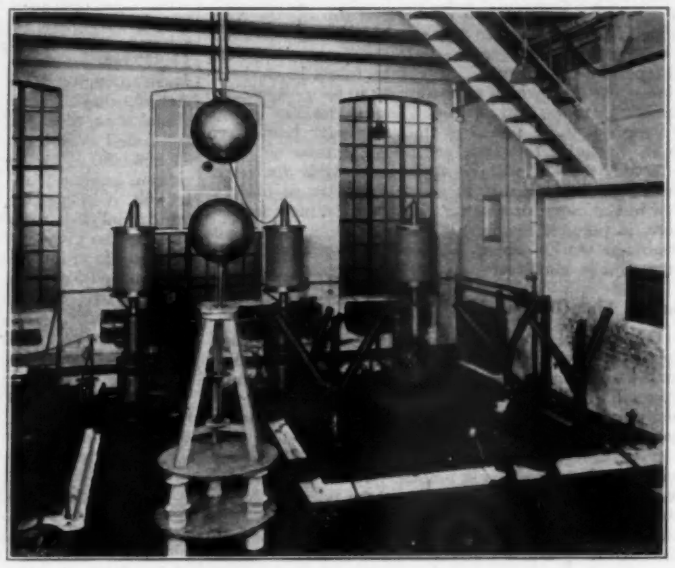
Broadcasting developments do not call for much comment, for the rapid progress that was made in this connection is familiar to almost everyone. There are now nineteen broadcast transmitters in Great Britain and Northern Ireland, including the high-power Chelmsford station, which has a transmission range five times greater than that of the other main transmitting stations. Listening-in to broadcast concerts by people travelling on ships at sea has hitherto been restricted by the fact that ships' wireless stations, and especially those on the larger passenger-carrying vessels, are more or less in continuous operation, and the heavy currents induced in the receiving aerial is out of all proportion to the feeble currents received from the distant broadcast station. But the Marconi Company has developed a receiver which is unaffected by the ship's telegraph transmission equipment, so that people at sea can now listen-in to broadcast concerts with practically the same ease as those on land.

The loud speaker problem, which has been tackled by a great many scientific people, received the attention of the well-known Marconi engineer, Captain Round. Under his direction the Marconi Company made important progress in connection with the transformation of electrical impulses into sound. Sound projectors were developed capable of dealing with electrical impulses up to a quarter of a kilowatt and for enabling sound to be heard at distances of over 1000 yards as clearly as if the speaker were speaking in a natural voice within a few feet of the listener, and extensive use of the new apparatus is being made for public address purposes. There was also continued progress in the development of thermionic valves, especially dull emitter valves, which will work with dry batteries, and in the construction of powerful water-cooled valves for transmitting purposes.

As regards the application of wireless to navigation, there was a considerable increase of the use of the direction finder at sea. No fewer than 168 British vessels now have Marconi direction finders, as compared with 122 last year. Beacon stations which transmit distinctive signals at regular times during each day and at all times during foggy weather are being erected in various parts of the world with a view to increasing the usefulness of the direction finding instruments on board ship. An improved Marconi beam direction finder was developed. Transmitting stations are erected at suitable points on the coast, and from these stations signals are projected in a narrow beam of, say, 15 deg. The beam is made slowly to revolve and a different Morse signal is transmitted as the beam points in succession to different selected points on the compass. With the aid of a simple form of receiver the observing officer on the ship "listens in" and so determines the direction in which the beam is pointing at a given instant, which is indicated by the particular signal he hears as the beam sweeps across the ship. This occurs at intervals of about one minute, and the navigator is therefore able to take a number of bearings at short intervals, and by co-ordinating these observations with the logged speed and course of the vessel he can determine his exact position by ordinary methods of triangulation. The operation of the receiver calls for no technical knowledge or skill on the part of the observer, who can make his own observations without the assistance of a wireless operator. The scheme brings the use of wireless for navigational purposes within the reach of every sea-going vessel, ranging from the smallest tugs, trawlers, &c., to the largest passenger vessels, and it enables them to navigate in the most congested waters and in the approaches to harbours at times of dense fog. The first station of this type was erected by the Marconi Company at Inchkeith last year, and it has been in successful operation ever since. A similar but improved station is now being erected at the South Foreland, and it is expected that it will be in operation within the next few months.

By the introduction of high-speed methods of signalling between ships' stations and the shore an important advance was made in ships' telegraph services. Messages can now be sent at the rate of 100 to 150 words per minute instead of 30 to 40 words per minute, thus enabling ships to clear their traffic in a comparatively short space of time. The transmission of photographs by wireless methods was another development. The pictures were sent during the latter part of the year from Radio House in London to New York, and it is well within the range of possibility





FIGS. 1 AND 2—HENLEY'S TELEGRAPH WORKS COMPANY'S LOW-TENSION LABORATORY AND CABLE TESTING DEPARTMENT

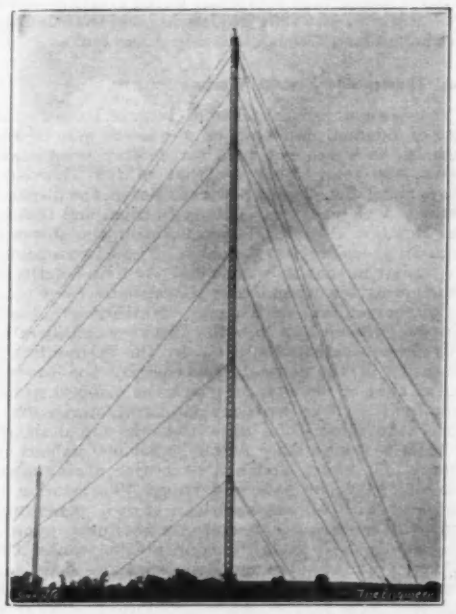


FIG. 3—A MAST OF THE RUGBY AERIAL

that within the next twelve months the system will be developed commercially. There was progress in the direction of linking up telephone networks with a wireless telephone system with a view to enabling two or more isolated telephone systems separated from each other by a considerable distance to be linked together by means of a radio channel acting as a trunk line between the two systems. The system is being used by the Marconi Company in connection with ships at sea and when approaching a port it will be possible for passengers to communicate with people on shore through the ordinary telephone system.

Two of the most important Post Office wireless jobs of the year were the erection of the masts—see Fig. 3—for the new Rugby station and the introduction of the coupled circuit at the Leafield station for the elimination of harmonics. Views of the new gear at Leafield are given in a Supplement to-day. There are to be twelve masts at Rugby, each 820ft. high. For feeding the plate circuits of the transmitting valves the British Thomson-Houston Company is supplying three 500-kilowatt motor generator sets, each consisting of a synchronous motor driving two direct-current generators and direct coupled exciters. Each generator develops a pressure of 3000 volts, and when connected in series will produce 6000 volts, the working pressure of each set, and as the three sets are designed to run in series the total pressure generated by the complete plant will be 18,000 volts.

SIXTY YEARS AGO.

SIXTY years ago the quality of London's water supplies was far from being satisfactory. The Londoner looked with envy at the water enjoyed by the citizens of Manchester, Edinburgh and Glasgow. The London water companies had exerted themselves in the matter. Following the passing of the Water Act of 1852, they expended upwards of 2½ millions on new works, largely on filter beds and other equipment for improving the quality of the supplies. But, according to an article in our issue of December 30th, 1864, the results were disappointing. In 1851 the organic impurities averaged 2.73 grains per gallon and the inorganic 19.53. By 1856 the organic impurities had been reduced to 1.24 grains, while the inorganic had increased to 20.93. This partial improvement had, however, not been maintained, for in 1863 the organic impurities had risen again to 2.58 grains per gallon and the inorganic had become 22.5. The people, we read, were driven to the use of domestic filters, few of which, it was noted, were satisfactory, principally because of the attention they required in order to prevent their becoming clogged by the impurities collected. . . . In the same issue appeared the fourth and concluding portion of a review of Jeaffreson and Pole's "Life of Robert Stephenson." We expressed disappointment with the two volumes in which this work was published. In their engineering aspect we found them "not better than the books of Mr. Smiles," while in their biographical aspects they were very much inferior. In spite of the adulation of these two volumes Robert Stephenson, we held, was not a man of genius. Had his father not lived before him he would never have attained the power which he acquired, for he did not possess the ability to push aside obstacles that prevented his rise. He made his mark before the "Hudson tribo" appeared on the scene. Had he lived at a later period of railway history he might have been thrust aside by unworthy and unscrupulous men. His power lay in his moral nature, the only twist in which arose from the depth of his affection for his father. He possessed practical sagacity and had a broad grip and common-sense view of physical and commercial practicability. He was a natural English gentleman, ever mindful of the interests of his pupils and workpeople and loyal to his friends. The judgment of a later generation, wise after the event, may halt somewhat over our reviewer's praise of Robert Stephenson's commercial perspicacity, particularly in connection with his, Stephenson's, opposition to the construction of the Suez Canal, a project which he held could be completed but which would serve no commercial purpose.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

FULLER'S UNITED ELECTRIC WORKS, Limited, of Chadwell Heath, Essex, informs us that its Swansea depôt has been removed from Pier-street to Waterloo-street (telephone No. 2608).

MR. F. J. KITSON asks us to announce that he left Gledhow-grove, Chapel Allerton, Leeds, yesterday, January 1st, and requests that hereafter all correspondence shall be sent to him at "Quarrydene," Westwood, Leeds.

WE are asked to state that the Flexible Shaft Manufacturing Company, of Church-street, Stratford, has appointed the Westminster Tool and Electric Company, Limited, of Westool Works, Putney Bridge-road, London, S.W. 15, selling agent for its flexible shafts and accessories.

COMMERCIAL DEVELOPMENTS IN EUROPE.—A series of ten lectures on "Commercial Developments in Europe," is to be given at the City of London College, White-street, Moorfields, E.C., on Mondays at 5.30, beginning on January 12th. Except in the case of France, the lectures will be given in English. They are designed particularly to acquaint City men with the latest commercial developments in the respective countries, and to help stimulate trade between those countries and Great Britain, and in each case the lecture will be given by an official representative of the country under discussion.

THE WHITWORTH SOCIETY.—The second annual commemoration dinner was held at the Holborn Restaurant, London, on December 20th, and proved a great success. Mr. R. B. Buckley, C.S.I. (the senior Whitworth Scholar, 1869), presided, and was supported by about eighty members. This year's Whitworth Scholars were invited as guests, and six of them accepted. The President announced that the Committee had elected Mr. Wm. Sisson, of Gloucester, Wh. Sch., 1874, as succeeding President. It is hoped that members will complete their "Who's Who" forms at once and send them in to the hon. secretary, care of the Institution of Mechanical Engineers, Storey's-gate, Westminster, S.W. 1.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Work Resumed.

WORK has now been resumed at most of the iron and steel mills in the Midlands and Staffordshire, though at some of the works stocktaking is still in progress, and plants are being overhauled in readiness for the trade of the New Year. Many of the concerns have fairly satisfactory order books to commence the New Year with, and there are prospects of business increasing as the quarter advances. The end of the year has found many manufacturers in a far better position than they had thought possible a few months ago, and they are optimistic enough to believe that trade will now go forward with greater momentum and steadier rhythm. There is improved confidence in industrial circles, and the lead given by the railway companies, it is considered, will be followed by local authorities and municipalities, who will no longer delay the putting in hand of schemes of improvement which have been mooted during the past twelve months or more. Gradually the conviction has gained ground that prices have in most departments of the material market reached bottom, and that now is a favourable opportunity to place contracts. On 'Change in Birmingham to-day—Thursday—inquiries were very numerous, and from them one might be lead to expect that at the quarterly meeting of the Midland iron trade next week some very good business will be booked. There has been very little forward buying at recent meetings of the trade, but the time appears to have been reached when consumers must assure themselves of ample supplies of iron and steel to enable them adequately to deal with the increased trade which is now considered to be almost assured during the first quarter of the New Year.

Raw Iron.

Demand for forge and foundry brands of pig iron is none too brisk, but the stocks which weighed upon the market until well into November have been liquidated, and some of the Midland makers are well sold into the early months of 1925. Many consumers, considering the price is as low as it is likely to be, covered a substantial proportion of their needs for about a couple of months ahead, but there are others who continue to buy more or less on hand-to-mouth lines. While new business is slow, producers adhere to the recent quotations, and on 'Change to-day at least one Derbyshire seller endeavoured to get an advance of 6d. per ton on foundry quality iron. This did not meet with the ideas of consumers, however, and the limited business transacted was put through at :—Northamptonshire forge, £3 11s. per ton at furnaces; No. 3 foundry, £3 16s. to £3 17s.; Derbyshire forge, £3 16s. 6d. to £3 17s. 6d.; foundry, £4 2s. 6d.; North Staffordshire forge, £3 17s. 6d.; foundry, £4 7s. 6d. Blast-furnacemen have during the past week been discussing the coke situation, the basis price being due for revision this week end. Since the basis was fixed at 16s. 9d. per ton for low grade coke supplied during the last quarter of the year, smelters who kept a free hand have been able to buy at appreciably lower terms than the contract rates. The market has made some recovery of late, but consumers associated with the scheme for grading prices of furnace coke according to quality as ascertained by analysis, feel that the arrangement is not working to their advantage. While the principle of the analytical test of value has justified itself with practice, the fairness of the scale which was tentatively applied is challenged. The basis price is fixed on coke containing 20 per cent, of moisture. This is a larger percentage than general blast-furnace economy recognises. Moreover, it is a standard which the cokeries would not find it safe to apply in the competitive conditions of the open market. While local blast-furnacemen have been paying the plusage provided by the scale for the quality of coke ordinarily employed for smelting in the Midlands, their competitors outside have been able to get the same quality at the minimum price. For a time they could buy it at about 9d. per ton below the minimum. It is on this ground the associated furnacemen claim an adjustment of the scale. The ovenmen will probably say that whereas those buyers who commit themselves forward under the scheme risk the market going against them, they also stand to gain if prices advance during the contract period. There are coke consumers who, it is stated, have hitherto bound themselves by the scale in advance who would prefer to abide the hazards of the open markets rather than commit themselves to prices which they believe would be all in favour of the seller. At the time of writing the new coke values is not known, but the general opinion appears to be that they will either remain unchanged or show some slight variation in favour of the consumer.

Staffordshire Bar Iron.

The Staffordshire bar iron trade has not so far undergone any material change. The call for marked bars is regular, and at a fairly good level, and a few orders have been taken from Midland wagon builders in connection with the contracts taken from the home railways. No alteration has been made in the £15 basis, and makers were in the happy position of being able to resume operations after the holidays with a reasonable amount of work on hand. Rollers of Crown bars find themselves very difficult to procure, and mills dealing with the class of iron are working practically from hand to mouth, and have a hard fight to maintain the basis price of £12 15s. Iron for the nut and bolt trade is asked for in very small quantities, only Belgian competitors having established an overwhelming ascendancy in this branch. The price in the Staffordshire district is £11 15s., at which producers cannot hope to compete with Belgian shippers at £7 17s. 6d., which is the price quoted this week. Much of the iron being used in the district was bought at an even lower figure than that. The Black Country nut and bolt industry remains fairly quiet, and suppliers of iron material are none too sanguine as to the immediate future.

Sheet Prices Easier.

The galvanised sheet mills have a substantial amount of work on hand for thin gauges, but many of them would like to balance their books better with orders for thick gauges. It is for this reason, no doubt, that the price has again been shaded to about £17 5s. for 24-gauge f.o.b. for export and at works for the home trade. The position for the New Year in nearly all departments is decidedly hopeful, but with ample capacity available, any large price changes are considered unlikely.

Steel Values.

The steel department continues to move forward. The quietest department is shipbuilding, very little demand coming from the shipyards, but constructional engineers are preparing numerous tenders, and good tonnages of this work are in vidw. There are inquiries out from wagon builders in connection with the contracts taken from the home railways. Some fair steel orders have already been booked. As to the other railway works which are to be undertaken in the near future there is no perceptible movement as yet. The steadiness of steel prices is a remarkable feature, and is attributable mainly to the keen competition from Belgium, coupled with the considerable plant still unemployed. For angles and joists £9 5s. continues the recognised figure, while tees are quoted £10 5s. There is very keen search for specifications, and makers anxious to find work for thier mills for the next few weeks are prepared to make concessions. Belgian steel has weakened slightly, but it is significant that though very attractive offers are made, orders are being returned where early delivery is a condition, the foreigners usually requiring nine or ten weeks for the supply of material. For native small bars £9 5s. is by no means a fair minimum, and they are in competition with Belgian bars at about £7 10s. delivered here. Tube works are able to buy steel strip as low as £9 10s. in cases ranging to £10. Bedstead angles are offered at £9 15s. The market for raw steel has been weakened a little by the unexpected falling off in the tin-plate trade, numerous Welsh mills having been obliged to enter the open market to dispose of their surplus output. This has lowered the standard for billets of medium qualities, and although the nominal figure is £7 10s., the ordinary medium quality can easily be bought at Welsh works at £7 5s. Offers of supplies have been received by Midland buyers this week at very low prices, £7 and even less being mentioned. The makers of high carbon and other special quality steels demand £7 15s. to £8. Belgian billets have weakened to about £6 5s., the general standard having been slightly reduced. The latest reports from Brussels forecast higher prices in the New Year, but this does not agree with British opinion, and native steel makers are not disposed to give further openings to foreign competition by price advances.

Scrap.

Orders and inquiries for steel scrap, which is very cheap, are more numerous, but they are strictly for delivery in the New Year.

Midland Electrical Workers' Wages.

The wages of all adult electrical workers in the West Midlands area whose wages are regulated by decisions of the Industrial Council have been advanced 2s. 6d. per week. Arising out of the report of the recent wages tribunal an application was considered at a meeting of the Council on December 5th for a general advance of 5s. per week in wages, as well as the restoration of the special reduction of 2s. 6d. per week in this district in January, 1923. After full consideration the trade union side of the Council agreed to withdraw the application for a general advance, and it was unanimously resolved that the application for a general advance in wages having been withdrawn, the Council should approve a recommendation going forward to the National Council for the restoration of the supercut of 2s. 6d. per week from and including the pay period covered by the pay day following December 1st, 1924, and the sliding scale agreement being brought into operation as from January 1st, 1925. The National Council for the industry has approved and confirmed this resolution.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

General Conditions.

READERS in the South will, of course, understand that in Lancashire and the North of England and Scotland, the New Year holidays are as important as the Christmas holidays, and in some districts even more important; and hence one cannot expect any very active business here until the following week. All the markets are, as a consequence, rather quiet, and attention is mainly directed to the improvement which is expected, especially in iron and steel, at the Birmingham quarterly meeting on January 8th. The meeting is rather early in the quarter this time, and gives all the more scope for improvement during January. It would, however, be rash to expect any very rapid advance in prices, for there are many reasons why prices should be kept at a moderate level, even if the demand for iron and steel material should improve rapidly—and that is not altogether probable.

Metals.

There has been a very firm feeling in the non-ferrous metal market for some time, and although the upward movement in copper is not rapid, there is a growing belief that we have at last left the very low prices behind us. Looking back, one sees that at the beginning of December best select ingot copper was cheaper by about £4 per ton than it is now, and such an advance during a period of very restricted trade is notable. Copper prices moved very little during last year, and the only time when they reached the present level was in March, when it was

hoped that a "spring revival" of trade was setting in. The market was disappointed last year, but the chances are better now than they were then, if only because we are another year farther off from the disasters of the war. It is noticeable that merchants here are more inclined to buy copper in anticipation of the demand, and that some consumers are inclined to hold larger stocks. If this kind of thing spreads to any extent, copper producers will soon be relieved of half their burdens. One is inclined to take a fairly favourable view of the market at the moment; but too much should not be expected of it. In the market for tin there is a very strong feeling here, and the fear of a slump in prices seems to be passing away. Those people who some time ago foretold that tin prices would again reach the £300 mark are now more than ever confident. Of course, the optimistic view is based on the fact that there is now no reserve of tin in the East, and that if any expansion of consumption should occur during the early months of the year there is no stock that would act as a sobering influence on the minds of speculators. The markets for lead and spelter keep very strong. Some doubt is expressed about lead here; but there is as yet no sign of any collapse. Spelter is also getting up to a fair height, although, of course, it is still cheap compared with lead. It is, however, dear compared with copper, and this fact is beginning to tell on the price of brass. In the end it should raise the value of scrap yellow brass, for a good mixture, say, 30–70, made from the new metals would now cost £62 per ton, whereas good heavy scrap brass is sold to dealers at £20 less.

Pig Iron.

The market here for foundry iron is very quiet, but at the same time it is not at all dull. Sellers, of course, cannot do very much business yet, but they show no signs of weakness. On the contrary, they seem to be expecting rather better prices in a week or two. For Derbyshire No. 3 90s. delivered is still quoted, and about 89s. for Northamptonshire. Lincolnshire remains scarce, and when any founder wants any of it, he may have to pay up to 92s. 6d. per ton, although, of course, the intrinsic value is no more than that of the other Midland pig irons. Cleveland foundry iron remains out of the reach of the Manchester ironfounder; but Cleveland hematite is fairly cheap for those who want it, being offered at 101s. per ton delivered, or at 6s. 6d. less than the quotations for No. 3 Scotch foundry iron.

Steel.

The market for steel does not show any favourable points yet. Works are evidently anxious for specifications, and are willing to make concessions for good straight orders for prompt execution. For ordinary business, £9 per ton is quoted for joists and angles; £9 15s. for plates and flat bars; and £10 to £10 7s. 6d. for round bar steel. The finished iron trade here is very dull, but, of course, the level of Lancashire prices is such that consumption cannot increase to any extent. Possibly buyers of iron for wagon work may pay the price, but there is now a great temptation to use steel in spite of the theory that it deteriorates more quickly.

Scrap.

There is now a much more cheerful feeling in the markets for scrap steel and for foundry scrap. As for heavy wrought scrap there is no great demand here, and one cannot see how there can be until the ironworks are better employed. Dealers are very firm now in the prices for good cast scrap, and for the best lot of "textile" material up to 90s. per ton is wanted. For ordinary qualities 85s. per ton seems now to be quite a moderate price. The demand for steel scrap has not set in yet, but it is expected early in the year, and in anticipation of it some dealers here have paid up to 70s. per ton on trucks for lots of heavy steel melting scrap. Not so long ago dealers were refusing to buy this class of scrap at 65s., talking of 60s. per ton for it.

The Engineering Trades.

The engineering trades of Lancashire have experienced a slight improvement during 1924, compared with the previous year, but their condition generally is indicated by the unemployment figures, and by the fact that many works in this district have been able to close for a full week for the Christmas and New Year holidays. Still, there are signs of improvement in many directions, and as I have previously pointed out, 1925 gives promise of better trade than its immediate predecessor. Unemployment is decreasing, if only slowly, especially amongst male workers, and inquiries are more numerous than they have been for some time. The large sums of money which are about to be expended by the railways will go chiefly into the hands of engineers, and Lancashire locomotive builders will benefit considerably. The outlook is distinctly brighter in this section of engineering. Machine tool builders, too, and especially those who have kept well abreast of the times, are better off for orders; in fact, there are a few firms which are really busy. Textile machinery makers are still far below the pre-war standard. The exports of this class of machinery during the past year showed a considerable decrease, and I am informed that the prospects of foreign trade are still gloomy, while the depressed condition of the textile industry at home and the monetary shortage are both acting detrimentally on the order books. There are many Lancashire mills which require overhauling and equipping with more up-to-date plant to produce efficiently and economically, but the trade conditions prohibit any material expenditure on this account. One of the principal firms building steam engines informs me that it is able to claim some improvement recently, both in the number of orders placed and inquiries, but in the Lancashire boiler industry there is little or no change for the better. The leading gas and oil engine builders in this district report that they have had a somewhat better year than in 1923, and that the outlook is rather more promising, especially for foreign markets, but competition for orders is very keen and prices are low. The two brightest branches of the industry are structural engineering and the manufacture of electrical apparatus.

BARROW-IN-FURNESS.

Hematite.

There has been the usual quietness during the holidays, but business will wake up again next week, and if the present signs are anything to go by, will gradually improve. It is not expected by anyone that there will be a sudden improvement in trade; in fact, there are people who predict that trade will not get into its proper swing until several months have passed—some say six. There is, however, a better tone altogether, and customers are more inclined to place orders for delivery several months ahead. The fact that the steel works are taking a considerable amount of iron is making it possible to keep fourteen furnaces in blast in the district, but if there is a stoppage for any length of time of the rail mills, the present output may be too big for the demand. The business done in special qualities promises to be better. Continental trade is slow, but there is some promise in the American business which has of late been better.

Iron Ore.

The iron ore trade is feeling the benefit of there being more furnaces in blast, and there is also a slightly better trade outside the district. None of the mines is fully at work, but a better tone exists. Business in foreign ores is moderately quiet, but the better business in the iron trade is likely to improve imports.

Steel.

There is little fresh to report as regards the steel trade. There is no news of more orders for rails, and unless some are booked in the early future the mills will have to stop. It is to be hoped that fresh orders will be forthcoming. The hoop and small section mills are better circumstanced, and have sufficient orders to keep them fairly well employed.

SHEFFIELD.

(From our own Correspondent.)

The Year's Quiet Close.

THIS has been another broken week in the Sheffield steel industry, as, although there was a resumption of work on Monday, the opening of the New Year is being celebrated by a second short holiday. The turn of the year found the heavy trades in a quiet state, with a poor demand for various raw materials and a tendency for pig iron prices to droop. A good deal of optimism prevails with regard to the future, but consumers are adopting a cautious attitude and waiting to see if the promised revival materialises. There were similar hopes of improvement in the closing months of the last year or two, but they were doomed to disappointment after a short spurt. At present, there seem to be good grounds for optimism. Continental competition has been on an abnormal scale, but prices now appear to be approaching an English level, and that encourages hopes of improvement. The threatened labour troubles in the Belgian iron trade may also affect the situation.

The Lighter Branches.

The manufactured side of the steel trade is in a healthier condition than that which produces semi-finished material. Several factories have lately been fairly busy on high-class small tools and special steels for various engineering purposes. There are many inquiries from the engineering industry, and the machine tool section, which has been suffering from a protracted slump, shows signs of recovery. A good volume of business is being done in files, saws, hammers, picks and shovels, and it is pleasing to know, on the authority of the Sheffield Chamber of Commerce *Journal*, that "Sheffield quality frequently beats the low prices quoted by certain foreign competitors." There is a good deal of activity in the manufacture of automobile steels and parts, engine and carriage fittings, steel and brass goods for electrical engineers, and also for railway workshops. For the most part, however, prices are cut so fine as to be very near the bare costs of production. There has been a considerable falling off in the demand for garden tools, owing to so many of the country's wartime allotments going out of cultivation.

Stainless Steel Progress.

The past year has seen continued development in the application of stainless steel to new purposes in engineering and metal working, and the demand from the cutlery trade has been well maintained. The use of stainless steel for small mirrors is one of the leading recent innovations. These articles are now being fitted in American and Canadian tramcars. They are highly satisfactory as reflectors, and have the added advantage of freedom from liability to breakage. The application of the material to the manufacture of stainless water taps and fittings is still in the experimental stage, progress being retarded by difficulties experienced in castings and also by high costs. The manufacture of hollowware offers a wide field for the use of stainless material, and some advance is being made towards meeting this market.

Cutlery and Plate.

The majority of the cutlery and plate works of the city are still closed. In cutlery, the volume of work done in the past year showed an increase on 1923, in both home and export markets. Competition among the makers has been so severe, however, that prices have been forced down to a very low level, and it is feared that in many cases the year's showing will not prove satisfactory. The plate industry has enjoyed a busy year so far as the cheaper lines of its products are concerned, and has also had good orders from hotels and restaurant proprietors, but the demand from the ordinary retail trade has been poor. The trade in Britannia metal goods has also been on a small scale.

Nottinghamshire Railway Schemes.

The increasing traffic arising from the development of the Nottinghamshire coalfield is calling for improved means of transport in the county, and the London and North-Eastern Railway Company is seeking powers to meet this need. The company has deposited a Bill for introduction into Parliament next session, under which it proposes to construct railways of a total length of 33 miles 5 furlongs. The most important section will consist of a new main line from Nottingham to Retford, with a length of 27 miles. This will commence by a junction with the company's Derbyshire and Staffordshire Railway, north of Gedling Station, and will terminate at East Retford by a junction with the company's Sheffield and Grimsby railway. From this main line several subsidiary lines will be constructed, forming junctions with the company's Chesterfield and Lincoln railway near Ollerton Colliery, and with its main line from London to York at East Retford. As part of this scheme it is proposed to widen the Derbyshire and Staffordshire railway at Gedling, between Colwick North Junction and Mussons Lane. A period expiring on October 1st, 1930, is sought in which to complete the work, and powers are asked for the raising of £2,000,000 additional capital.

A Tender for Tram Rails.

Sheffield will benefit by a decision of the Manchester Tramways Committee to reverse a previous recommendation as to the purchase of special track work. The first proposal was to give the contract to the United Steel Products Corporation of America, but that was referred back by the City Council, and the Committee now recommends the acceptance of the lowest British tender—that of Hadfields, Limited, of Sheffield—which is £85 higher than the American offer. A second matter which was referred back related to the purchase of steel tramway poles. In this case, the Committee reaffirms its previous recommendation that the contract shall be given to a firm in Czecho-Slovakia, the tender of which is £2000 less than the lowest received from this country.

NORTH OF ENGLAND.

(From our own Correspondent.)

A Gloomy Prospect.

No sentimental regret speeds the departure of 1924 from an industrial point of view. Looking back over the history of the last twelve months one has to confess that the process of raising industry from the slough into which it was plunged after the post-war boom of 1920 has been disappointingly slow; that the depression has proved more severe and prolonged even than was anticipated, and that the work of readjustment to a more normal state of affairs may yet occupy a considerable slice of the year which has now been entered upon. In no direction have the effects of the slump been more acutely felt than in the North of England iron and steel trade. Never, indeed, in all its history has the trade suffered so phenomenal a period of depression as that experienced during the past two years. Like that of the preceding year, the story of 1924 is one of ceaseless combat against adverse circumstances. Manufacturers found themselves almost powerless against foreign competition. Assisted by the peculiar conditions created by the economic chaos in Europe, competitors in France, Belgium, and Germany have not only been able to cut British manufacturers out of foreign markets, but they have flooded the British markets with iron and steel at a price considerably below the cost of production here. Hence the whole year witnessed a continuous struggle on the part of manufacturers to get their costs down, and thus attempt to restore British iron and steel to its former competitive pre-eminence. The fight, however, has not been a winning one. Costs of living, imperial and local taxation, transport charges, fuel prices, &c., have all been swollen to such an extent that even by eliminating all margin of profit they have not been able to compete with the manufactures of our near European competitors. The gap, however, is being gradually narrowed. The costs of production on the Continent are steadily rising, and it is noteworthy that French exports of iron and steel have fallen nearly 50 per cent. within a period of less than six months. This serves to strengthen the view now generally held that the worst has been experienced, and that in the months to come British manufacturers will be better able to compete in the world's markets.

Cleveland Iron Trade.

No industry suffered more from the depression than the Cleveland pig trade. The past year provided one long struggle against adverse circumstances. It is true that few anticipated 1924 would witness a complete return to activity, but even the chastened hopes of a year ago have not been realised, and the best that can be said is that after a further twelve months of unparalleled difficulty there are indications of more favourable conditions in the near future. The greatest difficulty has been the advantage which continental rivals have enjoyed as a result of steadily depreciating currency. It is merely a temporary advantage, and sooner or later the scales must turn, but meanwhile the further fall of the franc has enabled France and Belgium to encroach dangerously upon British trade and British markets. Producers have also been heavily handicapped by reason of dear fuel and transport charges. Railway rates still show an increase proportionately heavier than the increase in the selling price of iron. Over long distances the transport charges are up 50 per cent., but over short hauls the increase is nearly 100 per cent. in some cases, and in Cleveland, the proximity of which to the coal and iron deposits was the original foundation of its prosperity, short hauls are the rule rather than the exception, so that the present system of railway rates is especially oppressive to the iron trade in this area. At the close of 1924 some measure of stability seems to have been restored with regard to prices. For nearly two years past prices have been continuously falling, and whilst producers have had to make heavy

sacrifices in order to get down costs of production, and adjust working conditions to an ever declining scale of values, the continued weakness of the market has had the further effect of checking any buying movement amongst those consumers who were needing iron. On a falling market consumers find it a sound policy to buy from hand to mouth, with the result that few forward contracts were placed, and the difficulties of ironmasters incalculably increased on that account. During the year there was a decline of 18s. 6d. per ton in the price of Cleveland pig iron, and since March, 1923, the drop amounts to 46s. per ton. The decline was continuous until the end of March last, when 91s. was touched. Thereafter there was a sharp recovery to 95s., but it was not maintained and prices again fell, until at the end of June 88s. was quoted. During the next quarter the fall was more gradual, but by the end of September the market had got down to a quoted price of 80s., and there were sales as low as 78s. 6d. That was the minimum figure for the year. A revival subsequently set in, and after heavy sales, prompt and forward, the price recovered to 82s., and at the close of the year it was 6d. per ton below that figure. At the beginning of last year there were 48 blast-furnaces in operation on the North-East Coast, but by the end of it the number had been reduced to 40.

Hematite Pig Iron.

The course of the hematite pig iron trade during the past year was influenced by many adverse factors. On the North-East Coast there are now only 11 hematite furnaces working, compared with 17 in March last, and last January's output of 67,000 has not since been touched. There are, however, some present indications of recovery, notably recent sales to America, and there is a definite prospect of production being increased. This step has been assisted by the gradual liquidation of the heavy stocks of iron left on makers' hands earlier in the year. In early October it was estimated that the East Coast makers had fully 100,000 tons left on their hands, and there was a good deal of price cutting to liquidate those stocks. The year closed with East Coast mixed numbers selling at 14s. per ton less than at the beginning of 1924. The decline was continuous from January to the middle of October, when sales at 87s. per ton represented the lowest price of the year Since then the slight recovery has brought the selling price up to 88s. 6d., and at that figure there is a tendency for business to improve both with home and foreign consumers.

Manufactured Iron and Steel.

The past year was a most trying and difficult period for all concerned in the manufactured iron and steel trade. Manufacturers found it increasingly difficult to secure and maintain a foothold in foreign markets, and such trade as they were able to retain in face of unprecedentedly keen competition was very largely with our own Dominions. Yet even this trade is by no means secure. India, for example, instituted a heavy tariff in June last against all imported steel, and the effect in this district was observable in a subsequent marked contraction in exports of steel to that country. South Africa and Australia, usually two large customers to this district, are also endeavouring to foster home production. The greatest handicap, however, was in respect of high prices as compared with those quoted by continental competitors. Much of the manufactured iron and steel made during the past twelve months was sold at or below the cost of production, yet even so manufacturers were undersold by foreign rivals to the extent of £2 up to £3 per ton, and enormous quantities of foreign semi and finished steel flooded the home market. The outlook, however, is showing some improvement, owing to the fact that costs of production abroad are rising, so that British and continental prices are likely to come closer together. Moreover, confidence is returning in the home market, big constructional schemes are being launched, and more shipbuilding orders are being given out. The general conviction is that much brighter times are ahead.

The Coal Trade.

The Northern coal trade presents few new features of moment. Owing to holiday influences there is a very quiet movement in the export section, and buyers are not pressing inquiries or orders on the market. The few inquiries circulating for January are not of large volume, and while the general tone for the first half of the month is firm, the prospects for the full month are unsettled. For next week the principal collieries all report that they are well sold and stemmed, and contractors, who are not pressing supplies on the market, ask full recent prices, and at the same time show no disposition to make concessions ahead. The coke trade remains slow, and stocks steadily increasing all grades, are offered at easy values.

SCOTLAND.

(From our own Correspondent.)

A Depressing Year.

THE year just ended has been a most disappointing one in practically every sense of the word. Business in practically all departments of the steel, iron and coal industries sank to a very low ebb, the depression at times being equal to, if not actually, the worst ever experienced. Foreign competition played an important part in producing this state of affairs, home makers and owners being unable to compete against terms offered from abroad. In many instances, even when home prices were reduced to an unremunerative level, the business obtained was meagre in quantity. Occasional firmness in markets has been accounted for by considerable reductions in outputs causing a slight shortage when a temporary spurt was experienced in demands. The unsettled political situation created a feeling of anxiety which was added to by an unrest which permeated labour circles. An idea of the state of trade may be had from figures given relative to foreign imports of competitive material, compared with the preceding year. Imports of steel material showed an average increase of about 75 per cent. over 1923, while exports were down at least 10 per cent. In January last there were forty-four pig iron furnaces in blast, and the number dropped to under twenty, while the output will probably be in the region of 500,000 tons. The output for 1923 was about 750,000 tons. So far as regards quotations, a steady decline has been recorded, though the rate of depreciation has been slow. Steel prices are 10s. per ton cheaper than in January, 1924; pig iron from 15s. to 17s. 6d. per ton down; and bar iron 10s. per ton less. The coal trade, on the whole, has been very depressed. The loss of a great proportion of the export turnover has been sorely felt in certain districts, while the home trade has been far below par. Aggregate shipments from Scottish ports show a decrease of over 3,000,000 tons, compared with 1923. The general industrial outlook at the moment is considered to be more favourable, and it is hoped that by the month of March activities will be greatly increased.

"Holiday" Markets.

Practically no business of any importance has been done in steel, iron and coal during the past week, or, in fact, since just before Christmas. Attention has been confined to clearing up existing orders before the stoppage for the New Year vacation.

Steel and Iron.

There has been little indication so far of any expansion of demand in the steel trade. Makers of plates and sectional material are hopeful in view of increasing activities on the Clyde, but the price of foreign competitive material seems to preclude much chance for the home product meantime. Steel sheets are comparatively well placed for a month or two ahead yet. There has been a little more demand for bar iron, and the position at the works is a little more satisfactory. Re-rolled steel, on the other hand, continues a very drab market. A slight revival in pig iron is also anticipated, and it is hoped that the demand will warrant some addition being made to the number of furnaces in blast, which at present does not exceed thirty at the most.

Coal.

Apart from stemming and loading arrangements, there has been little done in the coal trade. The tone is slightly easier, as is indicated by the prices paid for small lots purchased to complete cargoes. The outlook is none too bright, as contracts are now practically worked off, while the amount of new business is meagre. Aggregate shipments for the week amounted to 277,240 tons, against 262,448 tons in the preceding week and 321,102 tons in the same week last year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Position.

THE steam coal trade is comparatively quiet, as was expected would be the case immediately following the holidays, and it is probable that the holiday influence will continue to be felt for the remainder of this week. The conditions are, on the whole, very unsettled. Colliery arrangements have suffered considerable dislocation as the result of the recent gales, which have damaged steamers and delayed the arrival of many others, so that the situation of a number of colliery undertakings is for the time being not an enviable one. Owing to tonnage not coming to hand as originally expected, collieries have not been able to get the quick outlet for their coals that they would have had in other circumstances, and, as a consequence, the market has slightly weakened for spot supplies: but for forward loading salesmen are looking for better conditions, as there is a possibility of tonnage arriving up together, and so causing greater activity, if not, indeed, causing some congestion. Business in steam coals cannot, however, be described as brisk, as although merchants hold a fair number of orders, new inquiries are not numerous, and the competition abroad, especially with German coals, is keen in the extreme. Fairly quiet conditions, so far as fresh operations are concerned, are therefore expected for a time, but later, when negotiations take a definite form regarding the new wages agreement, it is possible that buyers abroad may deem it advisable to take extra supplies for fear that there may be labour troubles on the termination of the existing agreement.

Tin-plate Trade.

As the result of the depression in the tin-plate and steel industries, the holidays of thousands employed in these trades were of much longer duration than usual. Fully 85 per cent. of the tin-plate mills ceased operations on Monday last week, and so far a number of them have not yet resumed, and may be idle all this week. Steel works furnaces were damped down on Christmas Eve, and their re-start depends entirely upon the activity of the tin-plate works. In one case, viz., that of Richard Thomas and Co.'s tin works at Aberearn, where work had been interrupted for a fortnight, a re-commencement was made on Monday by about 700 men. The outlook in the tin-plate industry for the New Year, while none too bright, is not viewed with any alarm. According to all accounts, manufacturers are not discouraged, especially as the stabilisation scheme is to operate for another twelve months; but developments arising from the attitude of the merchants towards the central agency for selling will be watched with some interest. Local, as well as London merchants appear to be strongly opposed to the Tin-plate Corporation, and last week local merchants followed the policy of the London merchants and decided to deal only with tin-plate firms outside the Corporation. The works associated with the Corporation do not appear, however, to be perturbed at the situation so far.

Coalfield Items.

So far as the coalfield is concerned, there have been few developments of interest. The Milfraen Colliery, belonging to the Blaenavon Company, closed down last week, presumably on account of the undertaking being unremunerative. The workmen, numbering about 750, had been working on day-to-day contracts for the previous fortnight. As the result of the heavy rains experienced in the Rhymney Valley, a landslide at Cwmsiflog caused a breakage of the compressed air main of the Powell Duffryn Company, running up the valley, and, as a consequence, between 4000 and 5000 workmen employed at the New Tredegar and Elliott collieries were rendered idle on Monday last; but fortunately the stoppage was not of long duration, as the damage was quickly repaired, and the miners were back at work on Tuesday. As the result of a dispute at the Tytrist Colliery, belonging to the Tredegar Coal and Iron Company, concerning the installation of a new weighing machine, 2000 men stopped work on Monday, but they resumed on the following day, and in the meantime negotiations are proceeding regarding the men's grievance.

Current Business.

There has been comparatively little business this week, and it will be next week before settled conditions are likely to prevail. Holiday influences are still at work, and values are somewhat erratic, owing to tonnage being delayed, with the result that colliery stems have become dislocated. Prompt coals can be secured at slightly under the prices usually quoted, but for shipment ahead colliery salesmen decline to accept any reduction, as they expect a certain amount of congestion to prevail when tonnage comes along more freely. The market is, however, to a large extent nominal. Pitwood, which showed a weakening tendency immediately before the holidays, is keeping fairly steady on account of the arrivals of supplies being held in check by the bad weather. Anthracite coals are quietly firm in the case of sized qualities, but large coals are slightly more plentiful.

Pipe Contract.

The Cardiff Waterworks Committee last week accepted the tender of Guest, Keen and Nettlefolds, Limited, Cardiff Works, for the supply of steel concrete-lined pipes for the second pipe line from Taff Fawr at the cost of £109,561. The manufacture of the pipes is a joint undertaking between Guest, Keen and Nettlefolds and Piggott and Co. Not only will the steel plates for the manufacture of the pipes be made in Cardiff, but the pipes will also be made locally, which means practically a new industry for the city.

CALENDARS, DIARIES, &c.

CROMPTON AND CO., Limited, Chelmsford.—Wall calendar with monthly tear-off sheets.

HENRY SIMON, Limited, 20, Mount-street, Manchester.—Wall calendar with daily tear-off sheets.

GEO. CRADOCK AND CO., Limited, Wire Rope Works, Wakefield.—Wall calendar with monthly tear-off sheets.

CASSELL AND CO., Limited, La Belle Sauvage, E.C. 4.—A copy of Letts's Engineer's Hand-book and Diary for 1925.

C. A. PARSONS AND CO., Limited, Heaton Works, Newcastle-on-Tyne.—Wall calendar with monthly tear-off sheets.

SULLIVAN MACHINERY COMPANY, Salisbury House, London-wall, E.C. 2.—Wall calendar with monthly tear-off sheets.

WELIN DAVIT AND ENGINEERING COMPANY, Limited, 5, Lloyd's-avenue, E.C. 3.—Set of refill cards for 1925 calendar.

NEWTON, CHAMBERS AND CO., Limited, Thorncliffe Ironworks, near Sheffield.—Wall calendar with daily tear-off sheets.

A. AND J. MAIN AND CO., Limited, Clydesdale Ironworks, Possilpark, Glasgow.—Wall calendar with daily tear-off sheets.

STEWARTS AND LLOYDS, Limited, Winchester House, Old Broad-street, E.C. 2.—Desk calendar for 1925 with monthly cards.

STANTON IRONWORKS COMPANY, Limited, near Nottingham.—Neat pocket diary full of information about the company's manufactures.

THE REASON MANUFACTURING COMPANY, Limited, Lewes-road, Brighton.—Refills for desk calendar 1925, also a small clothes brush.

THE ASSOCIATED BRITISH MACHINE TOOL MAKERS,' Limited, 17, Grosvenor-gardens, S.W. 1.—Wall calendar with monthly tear-off sheets.

WEBSTER AND SON, Limited, 104, Baker-street, W. 1.—Wall calendar with monthly tear-off slips. A view of Portrush Harbour is reproduced.

WESTINGHOUSE ELECTRIC INTERNATIONAL COMPANY, 2, Norfolk-street, Strand, W.C. 2.—Pocket diary for 1925, also fine art wall calendar with monthly tear-off sheets.

SIMPLEX CONDUITS, Limited, Garrison-lane, Birmingham.—Copy of the 1925 "Simplex" diary, which contains useful information and pages are ruled in small squares.

EDWARD WOOD AND CO., Limited, Ocean Ironworks, Manchester.—Wall calendar with monthly tear-off sheets. Pocket diary containing information useful to engineers.

AITON AND CO., Limited, Derby.—Wall calendar with monthly tear-off sheets. A collotype reproduction of "The Poplars of the Maas," after the painting by Mr. Bertram Priestman, R.A., R.O.I., is presented with this year's calendar. The picture measures about 12in. by 10in.

CONTRACTS.

HEENAN AND FROUDE, Limited, of Newton Heath, Manchester, have secured a contract for the building of a large power station at Ferrybridge, Yorkshire, for the Yorkshire Electric Power Company, Limited, and another for the building of a new works at Stafford, for the British Reinforced Concrete Engineering Company, Limited, of Manchester.

THE GENERAL ELECTRIC COMPANY, Limited, of Magnet House Kingsway, London, W.C. 2, informs us that it has secured through its railway signalling department the following orders:—From the India Office, for the supply of a large quantity of Edison primary cells and renewals, also track circuit relays, polarised relays and signal lever contact makers; from the Great Western Railway, for a twelve months' supply of track relays and track resistance units; and for the London and North-Eastern Railway, Southern area, for a twelve months' supply of track relays and track resistance units.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
Native	17/6 to 24/–
(1) Spanish	23/–
(1) N. African	23/–
N.E. COAST—	
Native	—
Foreign (c.i.f.)	22/6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	4 15 0	—
No. 1 Foundry	4 15 0	—
No. 3 Foundry	4 10 0	—
N.E. COAST—		
Hematite Mixed Nos.	4 8 0	4 8 0
No. 1	4 8 6	4 8 6
Cleveland—		
No. 1	4 6 6	4 6 6
Silicious Iron	4 6 6	4 6 6
No. 3 G.M.B.	4 1 6	4 1 6
No. 4 Foundry	4 0 6	4 0 6
No. 4 Forge	4 0 0	4 0 0
Mottled	—	—
White	—	—
MIDLANDS—		
(3) Staffs.—		
All-mine (Cold Blast)	10 10 0	—
North Staffs. Forge	3 17 6	—
,, ,, Foundry	4 7 6	—
(3) Northampton—		
Foundry No. 3	3 16 0 to 3 17 0	
,, Forge	3 11 0	—
(3) Derbyshire—		
No. 3 Foundry	4 2 6	—
Forge	3 16 6 to 3 17 6	
(3) Lincolnshire—		
No. 3 Foundry	4 2 6	—
No. 4 Forge	4 0 0	—
Basic	4 5 0	—
(4) N.W. COAST—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	5 2 6 (a)	—
	5 7 6 (b)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	12 0 0	—
Best ,,	—	—
N.E. COAST—		
Common Bars	12 0 0	—
LANCS.—		
Crown Bars	13 0 0	—
Second Quality Bars	12 0 0	—
Hoops	15 0 0	14 15 0
S. YORKS.—		
Crown Bars	13 0 0	—
Best ,,	13 10 0	—
Hoops	14 10 0	—
MIDLANDS—		
Crown Bars	12 15 0	—
Marked Bars (Staffs.)	15 0 0	—
Nut and Bolt Bars	11 15 0	—
Gas Tube Strip	13 5 0	—

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates	13 0 0	—
Ship Plates, ¾in. and up	9 15 0	—
Sections	9 10 0	—
Steel Sheets, 3/16in. to ¼in.	12 0 0	—
Sheets (Gal. Cor. 24 B.G.)	—	18 10 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	9 15 0	—
Angles	9 10 0	—
Boiler Plates	13 0 0	—
Joists	9 10 0	—
Heavy Rails	9 0 0	—
Fish-plates	13 0 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	9 10 0	—
Soft Billets	8 10 0	—
N.W. COAST—		
BARROW—		
Heavy Rails	9 0 0†	—
Light ,,	9 5 0 to 9 10 0	
Billets	8 0 0 to 11 10 0†	
MANCHESTER—		
Bars (Round)	10 0 0 to 10 10 0	
,, (others)	9 15 0 to 10 0 0	
Hoops (Best)	15 5 0	15 0 0
,, (Soft Steel)	13 15 0	13 10 0
Plates	9 15 0 to 10 0 0	
,, (Lancs. Boiler)	13 0 0	—
SHEFFIELD—		
Siemens Acid Billets	11 10 0	—
Bessemer Billets	13 0 0	—
Hard Basic	9 10 0	—
Intermediate Basic	9 0 0	—
Soft Basic	8 0 0 to 8 5 0	
Hoops	12 0 0	—
Soft Wire Rods	11 0 0 to 11 10 0	
MIDLANDS—		
Small Rolled Bars	9 5 0 to 10 0 0	
Billets and Sheet-bars	7 0 0 to 7 10 0	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	17 5 0	—
Angles	9 5 0	—
Joists	9 5 0	—
Tees	10 5 0	—
Bridge and Tank Plates	9 15 0	—
Boiler Plates	13 10 0	—

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	23/6 to 23/7½
Block Tin (cash)	272 0 0
,, (three months)	275 5 0
Copper (cash)	67 5 0
,, (three months)	68 7 6
Spanish Lead (cash)	44 0 0
,, (three months)	42 2 6
Spelter (cash)	39 5 0
,, (three months)	38 10 0
MANCHESTER—	
Copper, Best Selected Ingots	72 0 0
,, Electrolytic	73 0 0
,, Strong Sheets	97 0 0
,, Tubes (Basis Price)	0 1 1½
Brass Tubes (Basis price)	0 1 0½
,, Condenser	0 1 2½
Lead, English	46 10 0
,, Foreign	44 15 0

FERRO ALLOYS.

(*All prices now nominal.*)

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/8½ per lb.	
Ferro Tungsten	1/4½ per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£24 0 0	8/–
,, 6 p.c. to 8 p.c. ,,	£23 10 0	7/9
,, 8 p.c. to 10 p.c. ,,	£23 0 0	7/6
,, Specially Refined		
,, Max. 2 p.c. carbon	£43 0 0	16/–
,, ,, 1 p.c. ,,	£52 0 0	17/6
,, ,, 0.75 p.c. carbon	£60 0 0	20/–
,, ,, carbon free	1/5 per lb.	
Metallic Chromium	4/2 per lb.	
Ferro Manganese (per ton)	£15 for home, £15 for export	
,, Silicon, 45 p.c. to 50 p.c.	£11 15 0 scale 5/– per unit	
,, ,, 75 p.c.	£17 17 6 scale 6/– per unit	
,, Vanadium	17/6 per lb.	
,, Molybdenum	7/9 per lb.	
,, Titanium (carbon free)	1/2 per lb.	
Nickel (per ton)	£165	
Cobalt	10/– per lb.	
Aluminium (per ton)	£130	

FUELS.

SCOTLAND.

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	16/9
,, ,, Ell	18/9
,, ,, Splint	19/9 to 23/6
,, ,, Trebles	19/–
,, ,, Doubles	18/6
,, ,, Singles	15/–
AYRSHIRE—	
(f.o.b. Ports)—Steam	16/9
,, ,, Splints	19/9
,, ,, Trebles	19/–
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	15/1½ to 17/9
Screened Navigation	24/–
Trebles	20/6 to 22/–
Doubles	18/9
Singles	15/3
LOTHIANS—	
(f.o.b. Leith)—Best Steam	17/9
Secondary Steam	17/–
Trebles	19/6
Doubles	18/9
Singles	15/6

ENGLAND.

(8) N.W. COAST—	
Steams	28/6
Household	45/– to 58/4
Coke	30/–
NORTHUMBERLAND—	
Best Steams	18/6
Second Steams	17/6 to 18/–
Steam Smalls	10/6
Unscreened	15/6 to 17/–
Household	23/6 to 25/–
DURHAM—	
Best Gas	21/6
Second	18/3 to 18/6
Household	23/6 to 25/–
Foundry Coke	24/6

SHEFFIELD—	Inland.
Best Hand-picked Branch	32/– to 35/–
Barnsley Best Silkstone	26/– to 28/–
Derbyshire Best Brights	27/– to 32/–
,, ,, House	24/– to 26/–
,, ,, Large Nuts	22/6 to 25/–
,, ,, Small	14/– to 16/–
Yorkshire Hards	20/– to 22/6
Derbyshire ,,	19/6 to 22/–
Rough Slacks	9/6 to 12/–
Nutty ,,	8/6 to 10/6
Smalls	4/– to 6/6
Blast-furnace Coke (Inland)*	—
,, ,, (Export) f.o.b.	21/6 to 22/6

(9) SOUTH WALES.

CARDIFF—	
Steam Coals :	
Best Smokeless Large	27/3 to 27/9
Second ,,	26/– to 27/–
Best Dry Large	27/– to 27/6
Ordinary Dry Large	24/– to 26/–
Best Black Vein Large	24/6 to 25/–
Western Valley ,,	23/6 to 24/6
Best Eastern Valley Large	23/6 to 24/6
Ordinary ,,	22/6 to 23/–
Best Steam Smalls	16/– to 17/–
Ordinary ,,	13/– to 15/–
Washed Nuts	22/– to 32/–
No. 3 Rhondda Large	27/– to 27/6
,, ,, Smalls	19/– to 20/–
No. 2 ,, Large	22/6 to 23/6
,, ,, Through	18/– to 20/–
,, ,, Smalls	11/– to 13/–
Foundry Coke (export)	49/– to 47/6
Furnace Coke (export)	27/6 to 32/6
Patent Fuel	25/6 to 27/–
Pitwood (ex ship)	29/6 to 30/6
SWANSEA—	
Anthracite Coals :	
Best Big Vein Large	45/6 to 47/6
Seconds	36/6 to 38/6
Red Vein	32/6 to 35/–
Machine-made Cobbles	50/– to 55/–
Nuts	55/– to 60/–
Beans	44/– to 45/–
Peas	20/– to 23/–
Breaker Duff	9/3 to 9/9
Rubbly Culm	10/6 to 11/6
Steam Coals :	
Large	24/6 to 25/6
Seconds	22/6 to 24/6
Smalls	14/– to 16/–
Cargo Through	17/– to 19/–

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire, and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/– extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. * For blast-furnaces only, 16/9, with fluctuations according to analysis ; open market, round about 22/6 to 25/– at ovens. † Latest quotations available. (a) Delivered Sheffield or Glasgow. (b) Delivered Birmingham.

French Engineering Notes.

(From our Correspondent in Paris.)

New Import Duties.

In presenting the new scale of import duties to the Chamber of Deputies, the Government affirms that there is no intention of introducing a new Tariff Bill, but simply of adjusting some of the duties to the altered conditions of the manufacturing industries. The readjustment, however, appears to be so complete that the tariff must be regarded as an entirely new one, for if certain categories of goods remain unchanged, and are still subjected to the old system of coefficients, the new classification is so extensive as to imply considerable changes in the duties to be imposed on imported goods. The idea underlying the new arrangement is to classify the goods in such a way that each category will include products of approximately the same value. The fixing of duties *ad valorem* was rejected, on account of the difficulty of ensuring that the goods were of their declared value, and the only safe method therefore was to place products of approximately the same value together and to impose them by weight in the usual way. This has necessitated a particularly fine classification, and instead of lumping up certain classes of goods under one head, as is done at present, they are subdivided so that the duties on weight will more nearly approximate *ad valorem*. The new duties are supposed to be based upon what they were under the coefficient system, but, as a matter of fact, they will be found in many cases to be much higher. It has been declared that the duties will be imposed upon a gold basis. That has certainly been the intention of the Government, but to what extent it will be done can only be judged from the forthcoming debate. While higher protection will be accorded to many of the manufacturing industries, there is a reduction in the duties on goods and products of primary necessity, the idea being to favour the importation of products which will help to bring down the cost of living.

Tariff Examples.

As affording some idea of the nature of the proposed tariffs, the following examples will be instructive:—The minimum duties are given, the general tariff being in all cases three times as much. Machine tools, 65f. to 250f. per 100 kilos., according to the weight of the machines; flour-milling machinery, 60f. per 100 kilos.; elevating machinery, cranes, &c., 80f.; railway and tramway permanent way material, 40f.; boilers, 50f. to 90f., according to their character; machine parts in ordinary cast iron, from 55f. to 92f., according to weight; machine parts in wrought iron or steel, or in steel or malleable iron castings, 60f. to 230f., according to weight; fixed steam engines and marine engines, 75f. to 220f.; internal combustion engines of the Diesel, hot bulb and other types, 150ft. to 330f.; steam portables, 90f.; traction engines and road rollers, 60f.; machines for the preparation of textiles, 110f. to 150f.; motor cars, 600f. to 1200f., according to weight; tool steel, 50f.; special steels, 50f. to 200f., according to their character; manganese rails, 35f.

Marseilles-Rhone Canal.

The Marseilles Chamber of Commerce continues to take upon itself practically the whole of the burden of the cost of constructing the canal to the Rhone, which, when completed, will be one of the greatest enterprises carried out in this country. The canal from Arles to Port-de-Bouc, the Rove tunnel, the works in the Caronte and the canal extension to Marseilles are all so far advanced that the undertaking is likely to be completed at a comparatively early date. As the State has been unable to contribute its share towards the expense, the Chamber of Commerce has decided to make a further advance of 16,500,000f. to cover what is due from the State, so that there will be no interruption to the works which are under execution for opening up the Etang de Berre to navigation. Apart from the importance of the Etang de Berre as a means of regulating the future traffic between Marseilles and the Rhone, this vast lake is destined to play a considerable part in the development of trade with North Africa.

African Development.

The missions which are following each other from Algeria across the Sahara to the Niger Valley testify to the activity being displayed in putting the African colonies into direct communication with Marseilles. The transport difficulties which formerly made the Sahara a barrier to progress have been vanquished by the six-wheeled car and the endless track vehicle, which latter is, however, only employed over a short part of the journey, and the whole of the route from Colomb-Bechar to the Niger has again been covered by six-wheeled Renault cars. The object of the missions is to collect as much data as possible concerning the topography of the Sahara and the resources of the colonies with a view of settling upon some definite programme of transport. The idea of constructing a railway across the Sahara lost some of its interest when it seemed probable that the problem would be solved, at least partially by the aeroplane and the motor car, but a more complete knowledge of the route, and the possibility of employing locomotives with internal combustion engines have drawn further attention to the proposed railway.

Foreign Trade.

The returns of foreign trade during the first eleven months of 1924 show an excess in the values of exports over imports, the former being estimated at 37,412 million francs and the imports 36,014 million francs. The improvement was due largely to manufactured goods, the exports of which totalled 22,646 million francs. So far as the weight of goods was concerned, the 51,760,318 tons of imports included 45,220 204 tons of raw material, while the exports totalled 26,873,385 tons, including 22,089,016 tons of raw material and 3,282,502 tons of manufactured goods.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

CONDENSERS AND FEED-WATER HEATERS.

224,583. August 9th, 1923.—EVAPORATIVE CONDENSERS, The Ramsay Condensing Locomotive Company, 105, St. Vincent-street, Glasgow; and G. F. Jones, Stokesay, Queen's-road, Cheadle Hulme, Cheshire.

This condenser is primarily intended for such services as installation on locomotive engines. It is of the evaporative type and the inlet for the steam is shown at A. The steam finds its

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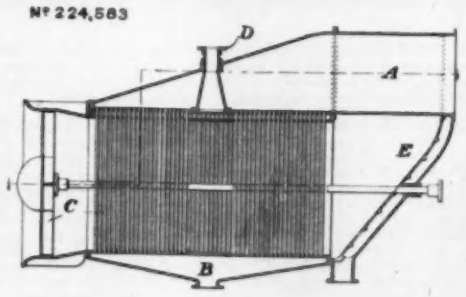

way down the nest of vertical tubes and the condensate is collected at B. A draught of air is blown through the casing containing the tubes by the fan C, and a spray of water is introduced at D. It is pointed out that the pressure of the water for the spray should be such that the sprays are turbulent, and any cooling water which might otherwise be blown out of the condenser by the draught is trapped by the perforated baffle plate E and drained away.—*November 10th*, 1924.

TELEGRAPHS AND TELEPHONES.

224,827. June 26th, 1923.—DEMAGNETISATION OF CONTINUOUSLY LOADED ELECTRICAL CONDUCTORS, The Western Electric Company, of Connaught House, Aldwych.

One object of this invention is to bring all sections of loaded communication conductors to a uniform condition. The loaded conductor is subjected to a novel demagnetising process, preferably after incorporation in the completed cable and as nearly

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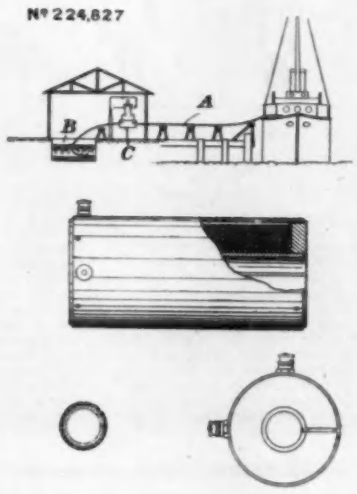

as possible at the end of the period of handling. Referring now to the drawing, a continuously loaded submarine cable A is shown in the process of being transferred from a water storage tank B in a factory to a cable ship. As the cable passes from the factory to the ship it is passed through a coil C, which is energised with alternating current. Details of the coil, which is fully described in the specification, are shown in the lower drawings.—*November 20th*, 1924.

TRANSMISSION OF POWER.

224,772. February 1st, 1924.—IMPROVEMENTS RELATING TO SYSTEMS OF ELECTRICAL DISTRIBUTION, Frederick William Le Tell, of 2, Norfolk-street, Strand, W.C. 2.

The inventor's object is to interconnect two electrical distribution systems in a flexible manner and so that disturbances on one system will not materially affect the other system. In the diagram turbo-generator units A supply energy to a high-voltage system with distributing conductors B and C. Across these conductors motors are connected. A motor generator set consisting of an induction motor E and a synchronous generator F is connected through a transformer G to the high-voltage system. A low-voltage system having conductors H and J is supplied with energy from a turbo-generator K. The load on this part of the system is shown at L and M, and a turbo-generator O operates in parallel with the generator K. In addition to the load imposed by the motors L other auxiliary apparatus may be operated by steam, the source of which also supplies the turbo-generators. For a change in conditions involving less steam from the house turbine for heating the feed water, a part of the load can be transferred to the main system by adjusting the governor of the turbo-generator K so as to reduce its speed to the desired degree. The necessary transfer of load can be simply and effectively controlled without interrupting the service of the auxiliaries L and M, inasmuch as the motor generator set automatically assumes a proportion of the auxiliary load corresponding to the lowering of the frequency below the normal of the low-voltage turbo-generator. Under abnormal conditions, such as result from a disturbance on the high-tension system, it will require a drop in frequency

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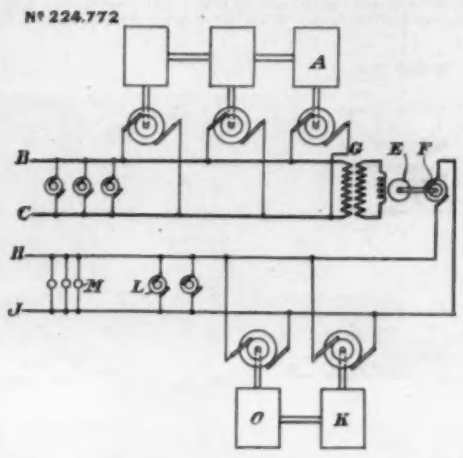

corresponding to the slip adjustment of the motor generator set automatically to transfer the load from the motor generator set to the turbo-generator K. A further reduction in the speed and frequency of the motor generator set of an equal amount would impose a corresponding additional load on the turbo-generator K.—*November 20th*, 1924.

MINING MACHINERY.

224,746. December 21st, 1923.—HAULING MACHINES, H. R. Bacon, 17, Brodie-street, Bainsford, Falkirk.

The inventor aims at reducing the overall dimensions of haulage gears used underground in mines, and for this purpose employs a pair of twin worm gears. The electric motor drives a shaft A on which there are cut two worms. Each of these

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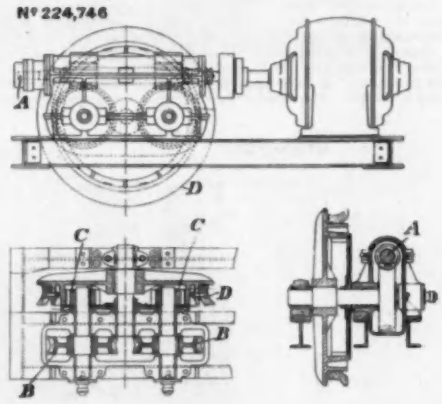

worms drives a worm wheel B and on the opposite ends of the shafts carrying these worms there are two pinions C C engaging with an internally toothed ring fixed to the Clifton wheel D. The inventor claims that by sharing the drive in this way, between two pinions, the gear is made unusually compact.—*November 20th*, 1924.

MACHINE TOOLS AND SHOP APPLIANCES.

224,768. January 24th, 1924.—FILES, E. Coenen, No. 252, Avenue van Volxem, Brussels, Belgium.

The principal claim for this invention appears to be the construction of a file by means of assembling a number of narrow blades on edge and then fixing them one to the other by auto-

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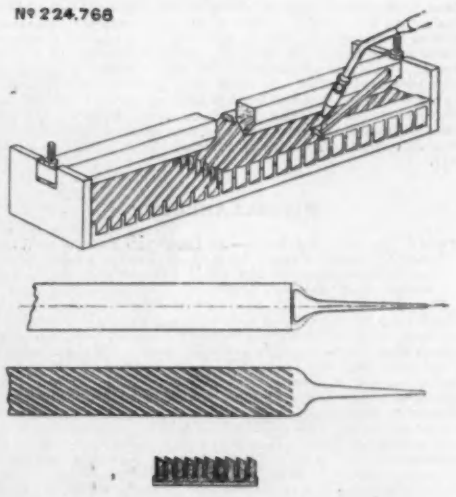
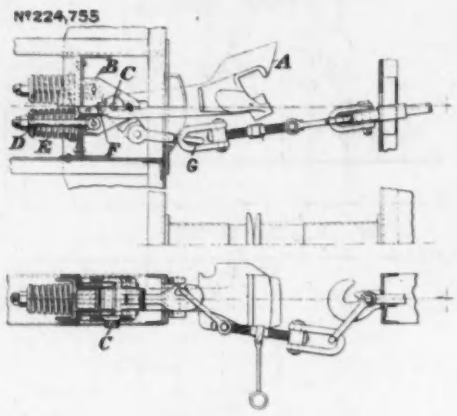


genous welding, while the tang is also attached by welding. The drawings show the rig used in welding up a file and a transverse section through a file. It is suggested that the blades might be welded together as wide units and then sawn up longitudinally to form narrow files.—*November 20th*, 1924.

TRAMWAYS AND RAILWAYS.

224,755. January 7th, 1924.—AUTOMATIC COUPLINGS, *A. E. White*, 88–90, *Chancery-lane, London, W.C.* 2.

This coupling is intended for the transitional stage when rolling stock is being equipped with automatic couplings. The automatic coupling hook A is of a recognised type and is connected with the draught casting B by a pin C working in a slot in the shank of the hook. When the coupling is under tension the

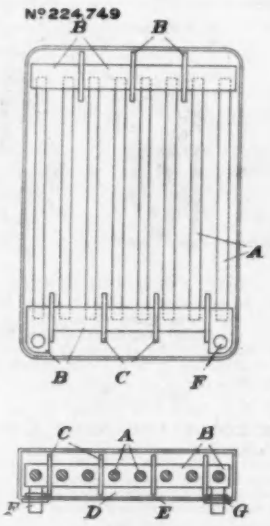


pull is transmitted to the wagon through the bolts D and compression springs E. If the coupling is under compression (buffing) the thrust is taken by the end of the shank bearing against the casting F and again putting the springs under compression. The hook G, for use with an ordinary screw coupling, is also secured by the pin C and lies behind the automatic hook A, so that it is not liable to damage. When in use it pushes the hook A sideways out of the way.—*November 20th*, 1924.

LIGHTING AND HEATING.

224,749. December 27th, 1923.—IMPROVEMENTS IN ELECTRIC HEATING APPARATUS, Howard Goodman, of "Banavie," Caterham, Surrey; and Hancock and Co., of Aurelia-road, Croydon.

The inventors' object is to produce an electric heating unit which will not burn out. They also aim at producing a resistance conductor which will not deteriorate. The resistance conductor is composed of carbon rods A connected together in series by blocks B which may be formed of graphite and in which the rods fit tightly, or they may be secured by cement or by other suitable means. The blocks B are insulated from each other by

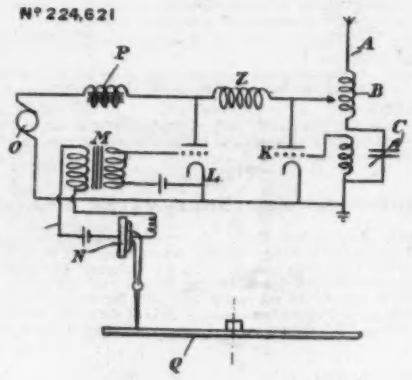


plates C of mica or other insulator, and the space D around the conductors and blocks is filled with some refractory material, such as carborundum, which, while being an electric insulator, is also a good heat conductor. The whole is enclosed in a metal case E, which prevents access of air and therefore protects the rods from oxidisation. In order to connect the heater with a supply circuit the first and last blocks of the series are fitted with short metal rods F passing through insulating bushes G and provided with binding screws, cable sockets or other suitable means for making connection with an external circuit.—*November 20th*, 1924.

MISCELLANEOUS.

224,621. August 22nd, 1923.—AN IMPROVED SYSTEM OF WIRELESS CONTROL, Vickers Limited, of Vickers House, Broadway, Westminster; and Cyril Percy Ryan, of Shotley House, East Molesey, Surrey.

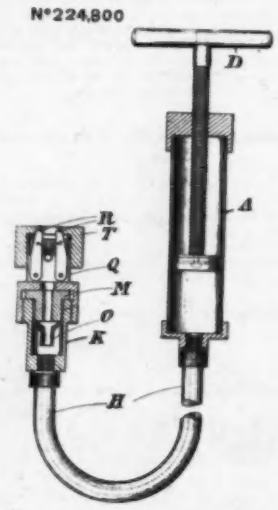
This invention relates to an improved wireless system whereby signals may be transmitted to a receiving station and employed to operate any apparatus it is desired to control, detection of the signals and possible resulting interference with the operation of the receiver being prevented by the method of adding confusing signals or impulses to the controlling signals. The apparatus comprises a wireless transmitter of ordinary type adapted to send impulses of audio frequency on a carrier wave of high frequency. In the diagram A is the transmitting aerial with tuning inductance B and variable condenser C. K is the oscillating valve having its grid coupled to the tuned inductance through a coil. L is a modulating valve operated through the low-frequency transformer M, the primary of which is in the circuit of the microphone N. O is the power source. A low-frequency choking coil P is inserted in the circuit between the modulating valve and the current source and a high-frequency choking coil Z is inserted between the two valves. To transmit the controlling signals at the required rate and having the desired acoustic frequency or frequencies a sound record disc Q is included, and on it rests the usual gramophone needle, the lever of which operates the microphone N. The sound record disc is cut with a record giving, when the disc is rotated at the proper speed, a succession of signals at the required acoustic frequency or frequencies to operate the receiving circuit. Other inoperative



or confusing signals are superimposed upon the record, so that a listener-in would find it impossible to detect the controlling system, while the superposed or confusing signals have no effect upon the tuned receiving system.—*November 20th*, 1924.

224,800. April 8th, 1924.—IMPROVEMENTS IN OR RELATING TO THE SEALING OF THE ENDS OF ELECTRIC CABLES, W. T. Henley's Telegraph Works Company, Limited, of 13 and 14, Bloomfield-street, London-wall, E.C. 2.

In the use of electric cables of certain types, such, for instance, as lead-covered rubber insulated cables for wiring buildings, the weakest parts of the system are frequently at the open ends of the cables, such as at switches, ceiling roses, wall plugs, &c., where the dielectric is exposed to the atmosphere. The object of this invention is to provide a simple and easily operated device for enabling insulating compound to be forced into the end of the cable so as to seal it. The operation of the device, which is illustrated in the accompanying drawing, is as follows:—The



end of the cable to be sealed is trimmed and inserted between the grips R and forced through the gland M and the extension O. The nut T is then screwed down on Q to tighten the grips R and prevent the cable from being forced out of the gland when pressure is put on to the compound in the cylinder A by twisting the handle D. When it is considered that sufficient compound has been forced along the tube H into the cable the nut T is released and the cable withdrawn. If desired, the coupling between the cylinder A and the cup or holder K may be rigid, or rigid sections may be coupled together by flexible joints. The device, which is portable, may be packed in a case with supplies of compound, spare glands, adjusting spanners, &c. —*November 20th*, 1924.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, London, S.W. 1. Lecturette, "Modern Flour-milling Machinery," by Mr. W. Ringrose. 7.30 p.m.

MONDAY, JANUARY 5TH.

BRADFORD ENGINEERING SOCIETY.—The Technical College, Bradford. Lecture, "Geared Steam Turbine Drive for Textile Mills," by Mr. B. C. Johnson. 7.30 p.m.

INSTITUTE OF TRANSPORT.—Institution of Electrical Engineers, Savoy-place, London, W.C. 2. Paper, "Recent Developments in the Industrial Aspects of Transportation," by Brigadier-General H. O. Mance. 5.30 p.m.

INSTITUTION OF CIVIL ENGINEERS: NEWCASTLE-UPON-TYNE ASSOCIATION.—Neville Hall, Newcastle-upon-Tyne. Paper, "The Newcastle and Carlisle Railway—90 Years Ago and To-day," by Mr. F. E. Harrison. 7.30 p.m.

JUNIOR INSTITUTION OF ENGINEERS: NORTH-WESTERN SECTION.—Manchester Geographical Society's Rooms, 16, St. Mary's Parsonage, Manchester. Presidential address, "The Outlook of Engineering," by Mr. A. P. M. Fleming. 7.15 p.m.

TUESDAY, JANUARY 6TH.

INSTITUTE OF MARINE ENGINEERS.—85-88, The Minories, Tower-hill, London, E. 1. "Some Considerations in Connection with the Measurement of Liquid Fuel Storage and Liquid Depths," by Mr. C. H. Wright. 6.30 p.m.

INSTITUTE OF METALS: BIRMINGHAM LOCAL SECTION.—Chamber of Commerce, New-street, Birmingham. Paper, "Cobalt, its Production and Some of its Uses," by Mr. T. H. Gant. 7 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS: COVENTRY CENTRE.—Broadgate Café, Coventry. Discussion on "A Criticism of Breakdowns." 7.15 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: MANCHESTER SECTION.—Milton Hall, Manchester. Faraday lecture, "World-wide Radio Telegraphy," by Professor G. W. O. Howe. 7.30 p.m.

INSTITUTION OF PETROLEUM TECHNOLOGISTS.—Royal Society of Arts, John-street, London, W.C. 2. Paper, "The Behaviour of Lubricating Oils under Oxidising Conditions," by Mr. J. B. Hoblyn. 5.30 p.m.

WEST YORKSHIRE METALLURGICAL SOCIETY.—George Hotel, Huddersfield. Discussion on "The Value of Some Workshop and Laboratory Tests." 7.30 p.m.

WEDNESDAY, JANUARY 7TH.

INSTITUTION OF AUTOMOBILE ENGINEERS: DERBY CENTRE.—Cavendish Café, Cornmarket, Derby. Paper, "Developments and Possibilities of the Multi-cylinder Two-stroke Engine," by Mr. R. W. Bent. 7.30 p.m.

INSTITUTION OF CIVIL ENGINEERS: MANCHESTER AND DISTRICT ASSOCIATION.—Rooms of the Literary and Philosophical Society, George-street, Manchester. Paper, "The Present Field for the Quick Revolution Steam Engine," by Mr. R. A. Baldwin.

INSTITUTION OF CIVIL ENGINEERS.—Students' visit to the Wandsworth Gasworks.

INSTITUTION OF ELECTRICAL ENGINEERS.—Savoy-place, Victoria Embankment, London, W.C. 2. Wireless Section meeting. "A New Method of High-frequency Resistance Measurement," by Professor E. Mallett and Mr. A. D. Blumlein. 6 p.m.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS.—The Engineers' Club, Coventry-street, London, W. 1. Paper, "Water Gauge," by Mr. Oswald Stott. 7 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—Royal Society of Arts, John-street, London, W.C. 2. Presidential address by Dr. Alexander Russell. 7.30 p.m.

THURSDAY, JANUARY 8TH.

INSTITUTE OF METALS: LONDON LOCAL SECTION.—Institute of Marine Engineers, 85/88, The Minories, Tower-hill, London. E. 1. Paper, "Extensometers," by Dr. R. H. Greaves. 7.30 p.m,

INSTITUTION OF AUTOMOBILE ENGINEERS: SCOTTISH CENTRE.—Royal Technical College, Glasgow. Joint meeting with the Institution of Mechanical Engineers. Lecture, "Traction Across Rough and Roadless Country," by Mr. L. A. Legros. 7.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS.—Savoy-place, Victoria Embankment, London, W.C. 2. "Three-wire Direct-current Distribution Networks: Some Comparisons in Cost and Operation," by Mr. H. W. Taylor. 6 p.m.

INSTITUTION OF MECHANICAL ENGINEERS: NORTH-WESTERN GRADUATE SECTION.—The Engineers' Club, Manchester. Paper, "The Reduction of Factory Costs," by Mr. E. H. Lewis. 7 p.m.

ROYAL AERONAUTICAL SOCIETY.—7, Albemarle-street, London, W. 1.—Discussion on "The Use of the Wind Channel to Aircraft Designers." 5.30 p.m.

FRIDAY, JANUARY 9TH.

INSTITUTE OF METALS: SHEFFIELD LOCAL SECTION.—Mappin Hall of the University, St. George's-square, Sheffield. Paper, "Die Casting," by Mr. A. H. Mundey. 7.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's Gate Westminster, London, S.W. 1. Informal meeting. "The Maintenance of High-compression Oil Engines." 7 p.m.

MONDAY, JANUARY 12TH.

INSTITUTE OF METALS: SCOTTISH LOCAL SECTION.—Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank-crescent, Glasgow. Open discussion. 7.30 p.m.

INSTITUTE OF TRANSPORT: YORKSHIRE LOCAL SECTION.—Town Hall, Leeds. Inaugural address by the Chairman, Mr. J. B. Hamilton. 5.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS: BIRMINGHAM SECTION.—Chamber of Commerce, New-street, Birmingham. Lecture, "The General Manufacture of Rubber," by Dr. S. S. Pickles. 7 p.m.

TUESDAY, JANUARY 13TH.

INSTITUTE OF METALS: NORTH-EAST COAST LOCAL SECTION.—Armstrong College, Newcastle-on-Tyne. Paper, "Brazing," by Mr. A. R. Page. 7.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS: COVENTRY CENTRE.—Broadgate Café, Coventry. Paper, "Piston Rings," by Mr. A. E. Barrett. 7.15 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Lecture, "The General Manufacture of Rubber," by Dr. S. S. Pickles. 7 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, Westminster, London, S.W. 1. Papers, "The Investigation of the Surge-tank Problem by Model Experiments," by Professor A. H. Gibson; and "The Flow of Water in Pipes and Channels," by Mr. F. Heywood. 6 p.m.

INSTITUTION OF MECHANICAL ENGINEERS: SOUTH WALES BRANCH.—Chamber of Commerce, Adelaide-street, Swansea. Annual general meeting. Lecture, "Steel Construction as Applied to Steel Works and Mill Buildings," by Mr. A. A. Fordham. 6 p.m.

MANCHESTER METALLURGICAL SOCIETY.—College of Technology, Manchester. Paper, "Tool Steels," by Mr. F. C. H. Lantsberry. 7 p.m.

WEDNESDAY, JANUARY 14TH

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, London, S.W. 1. Informal meeting. Discussion on "The Use and Abuse of Reinforced Concrete," introduced by Mr. H. J. Deane. 7 p.m.

RADIO SOCIETY OF GREAT BRITAIN.—Institution of Electrical Engineers, Savoy-place, Victoria Embankment, London, W.C. 2. Informal meeting. "Some Notes on Short Wave Reception," by Mr. S. Ward. 6 p.m.

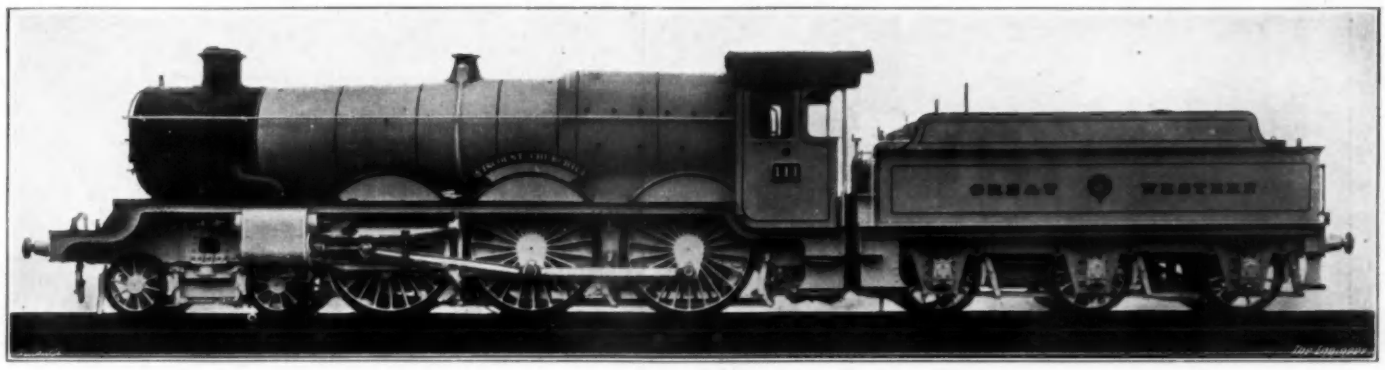
THURSDAY, JANUARY 15TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Watergate House, Adelphi, London, W.C. 2. Graduates' meeting. Paper, "Steam Vehicles for Road Transport," by Mr. A. E. L. Collins. 7.30 p.m.

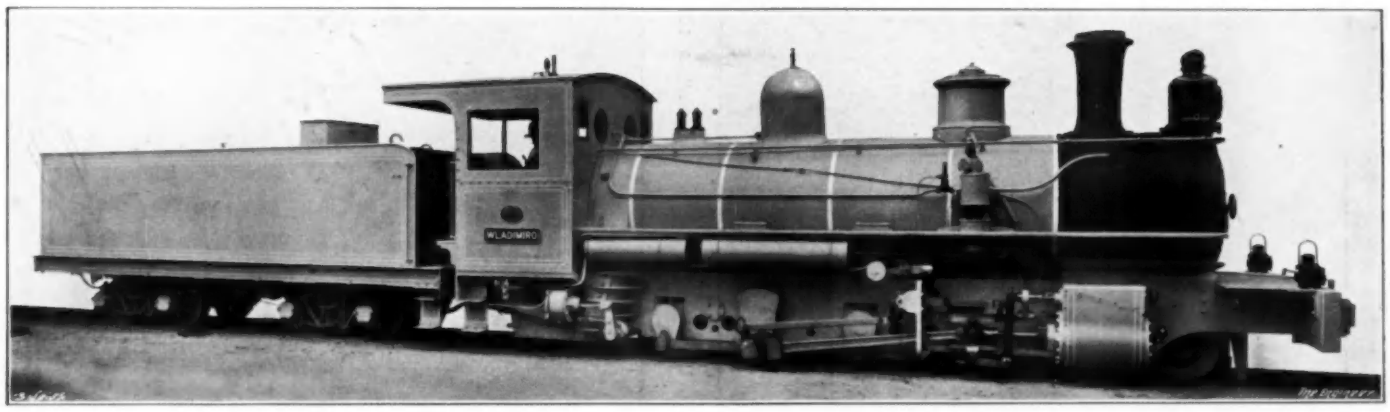
FRIDAY, JANUARY 16TH.

CHEMICAL ENGINEERING GROUP.—Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Joint meeting with the Society of Chemical Industry. Discussion on "The Low-temperature Treatment of Bituminous Materials." 8 p.m.

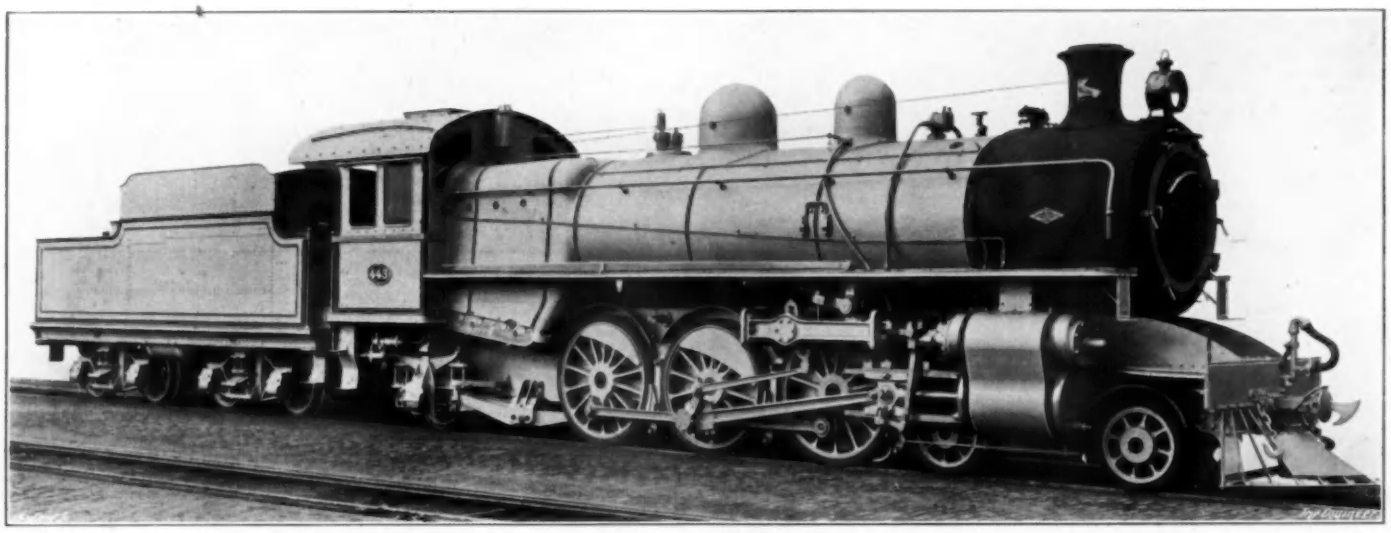
SOME LOCOMOTIVES OF 1924



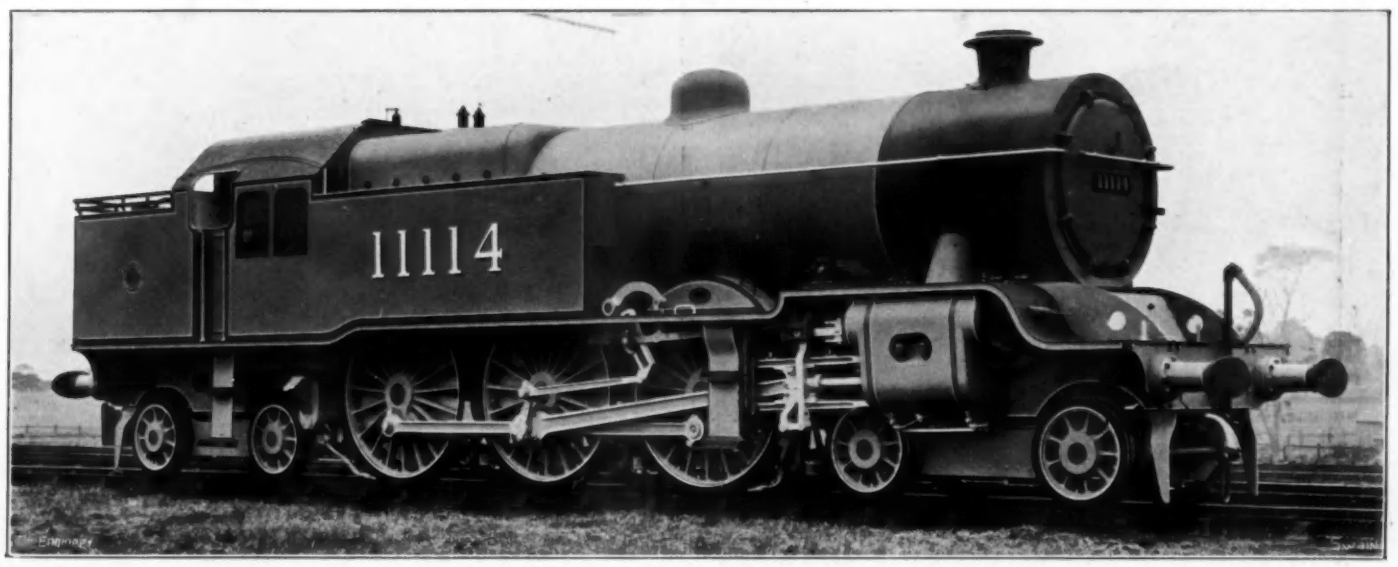
GREAT WESTERN RAILWAY—4-6-0 PASSENGER ENGINE VISCOUNT CHURCHILL



HUNSLET ENGINE COMPANY—2-8-0 LOCOMOTIVE FOR A CHILIAN NITRATE MINING LINE

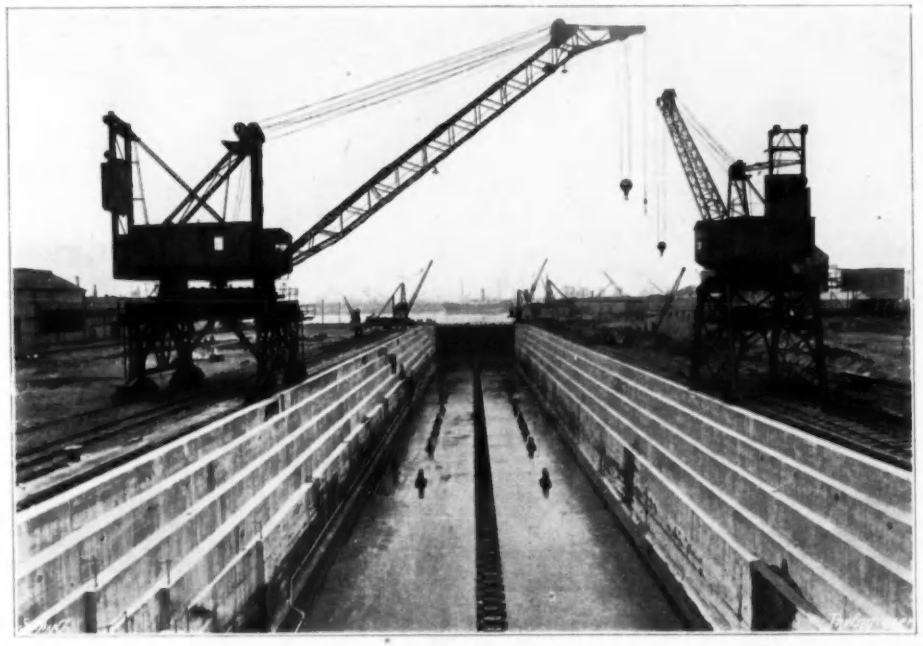


NORTH BRITISH LOCOMOTIVE COMPANY, LIMITED—3ft. 6in. GAUGE LOCOMOTIVE FOR THE WESTERN AUSTRALIAN RAILWAYS



LONDON, MIDLAND AND SCOTTISH RAILWAY—BALTIC TANK LOCOMOTIVE

THE SENNAR DAM—DOWN STREAM FACE OF EASTERN PORTION—JULY 1, 1924

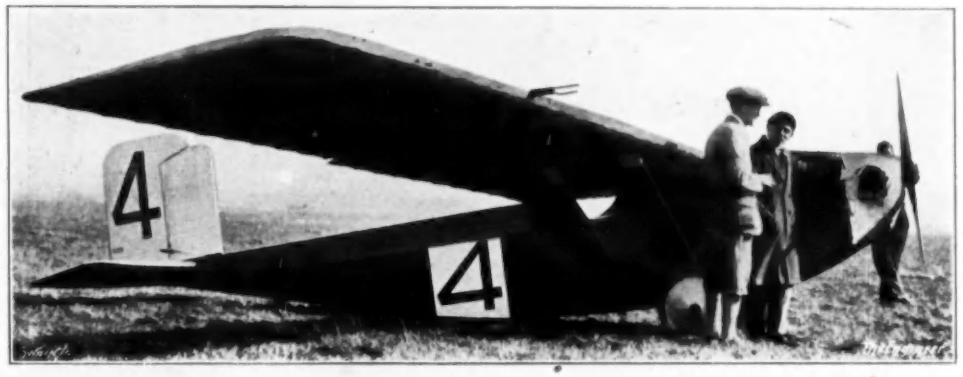


SWANSEA DRY DOCK

TIDAL STORAGE AND SEDIMENTATION TANKS, RAINHAM SEWAGE WORKS

TRENT NAVIGATION IMPROVEMENT—HOLME LOCK

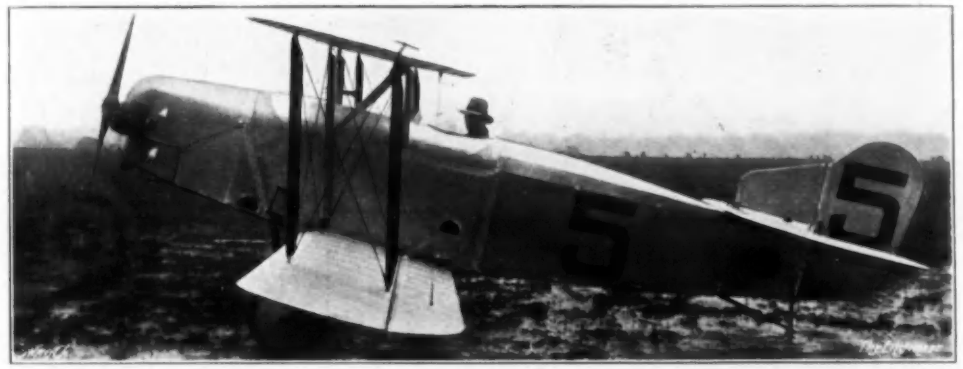
SOME LIGHT AEROPLANES OF 1924



BEARDMORE WEE BEE I. MONOPLANE

GLOUCESTERSHIRE GANNET BIPLANE

WESTLAND WIDGEON MONOPLANE

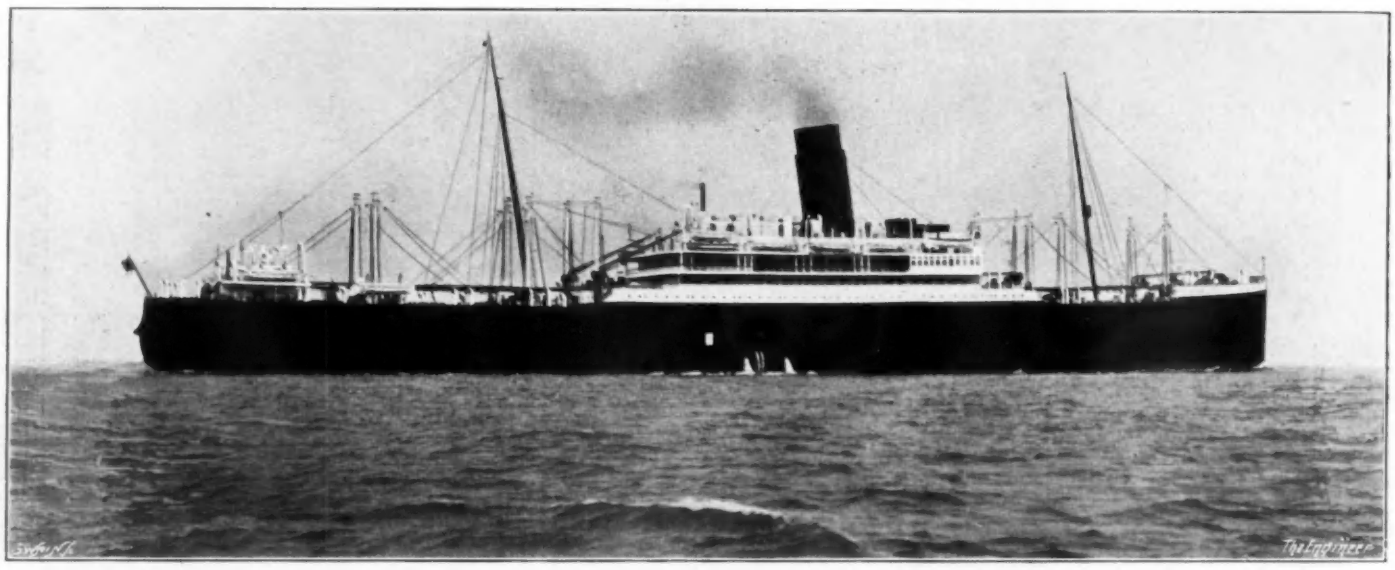


WESTLAND WOOD PIGEON BIPLANE

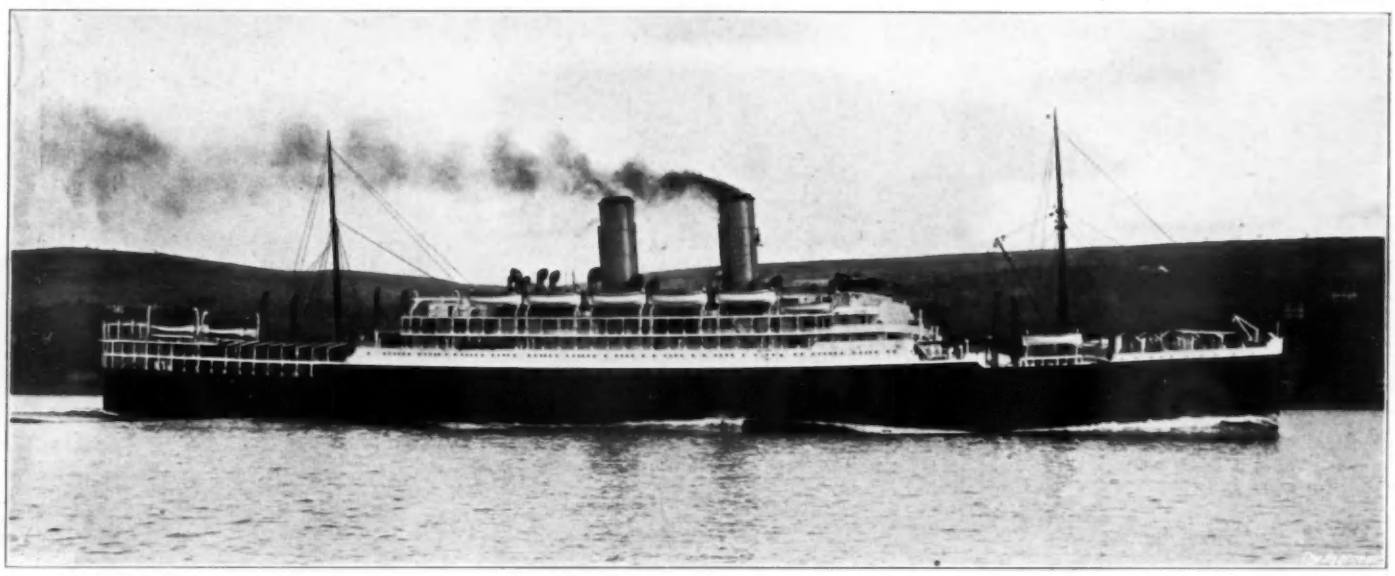
FARNALL PIXIE III. MONOPLANE

HAWKER CYGNET II. BIPLANE

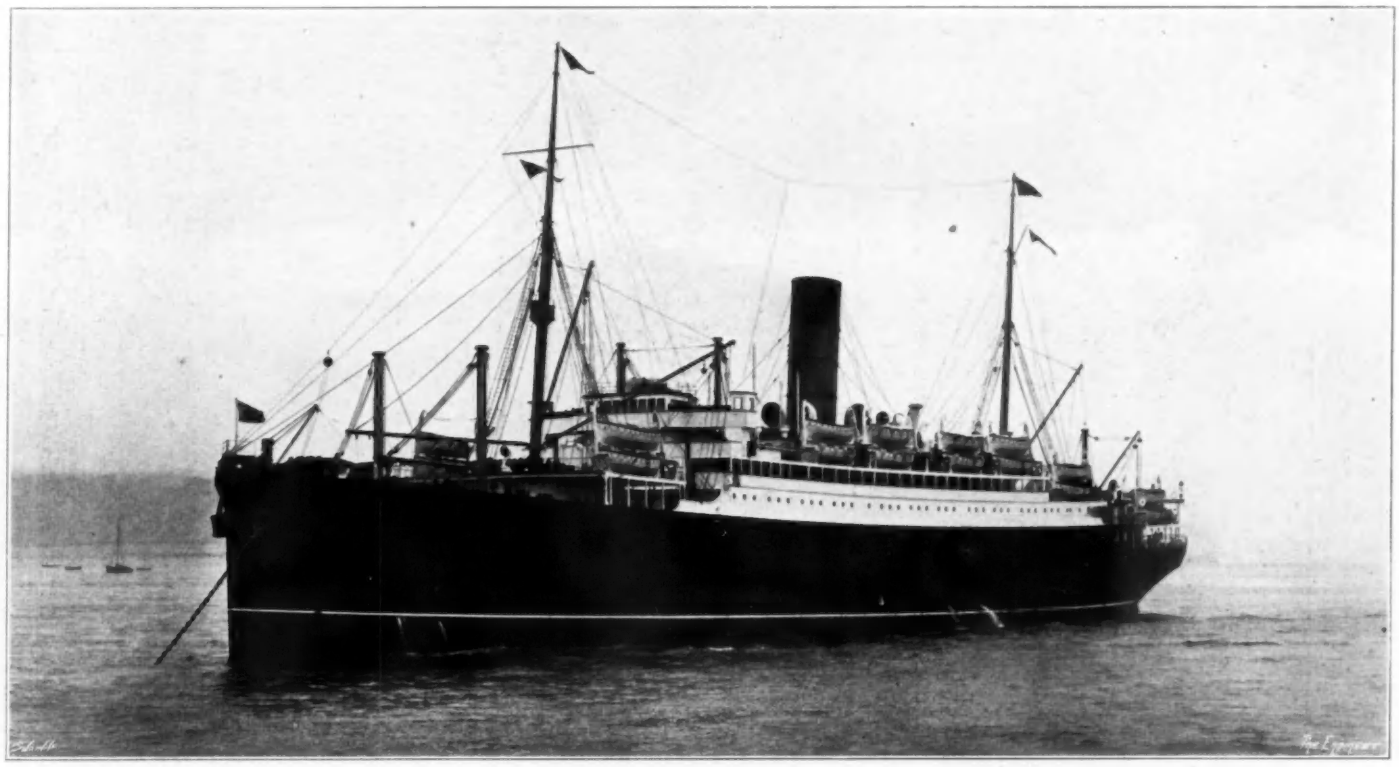
SOME LINERS OF 1924



THE ATLANTIC TRANSPORT TWIN-SCREW LINER MINNETONKA

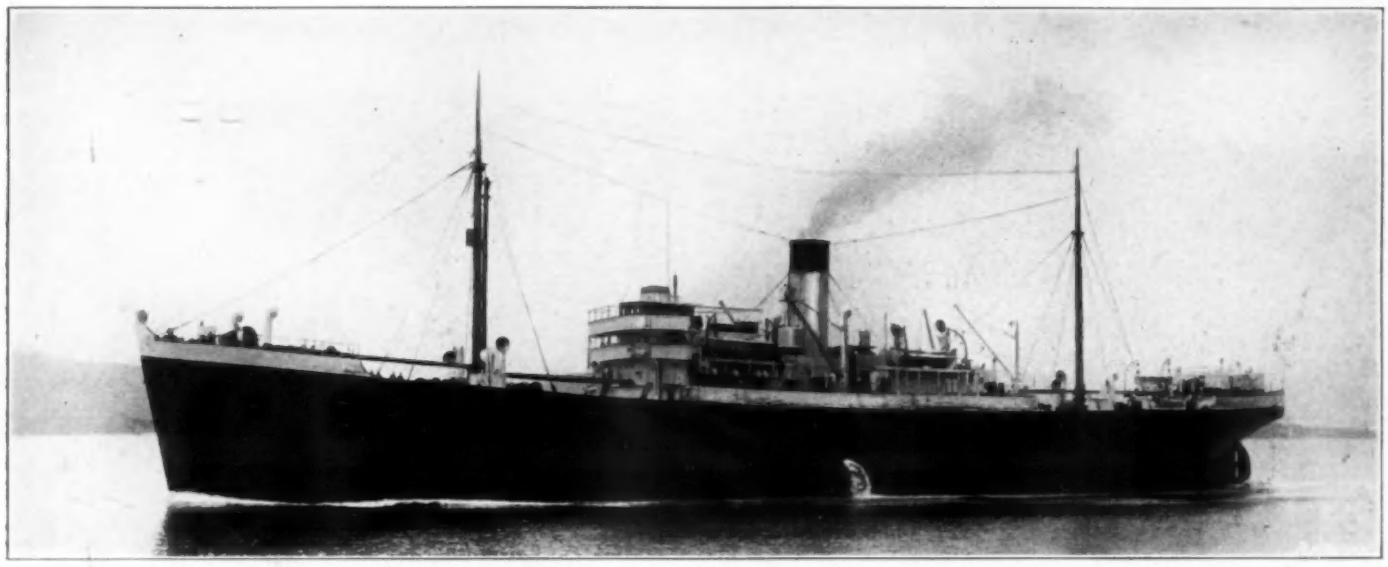


THE ORIENT TWIN-SCREW LINER ORAMA

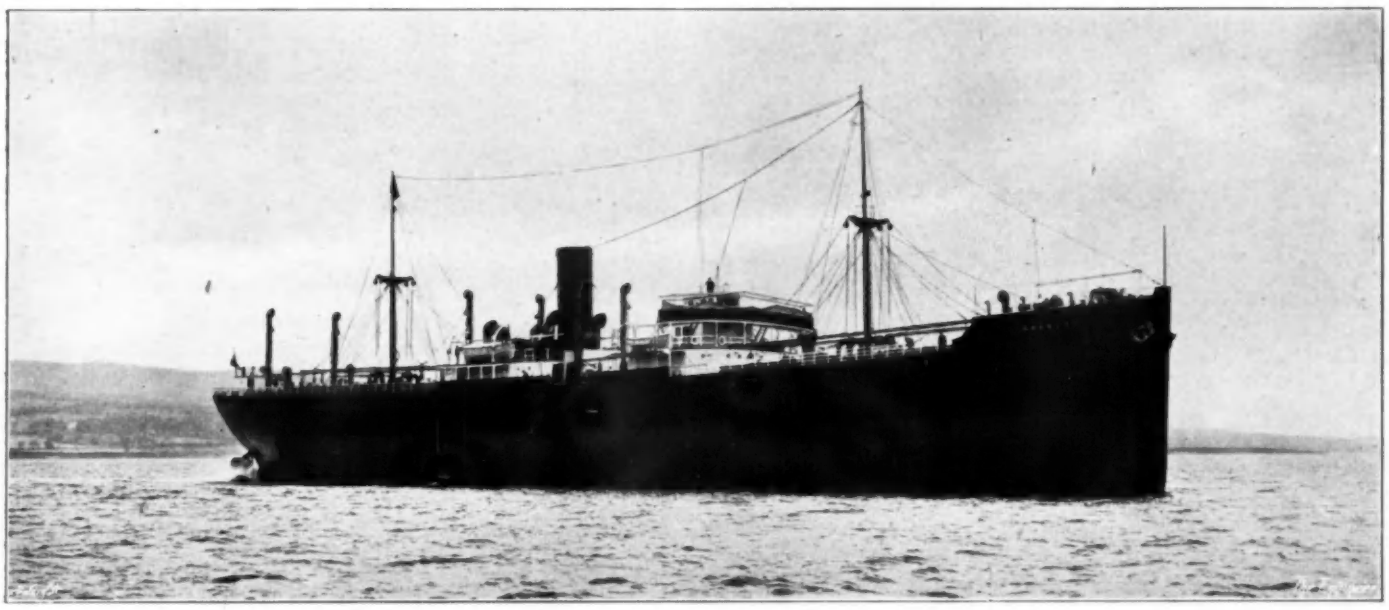


THE CUNARD TWIN-SCREW LINER AURANIA

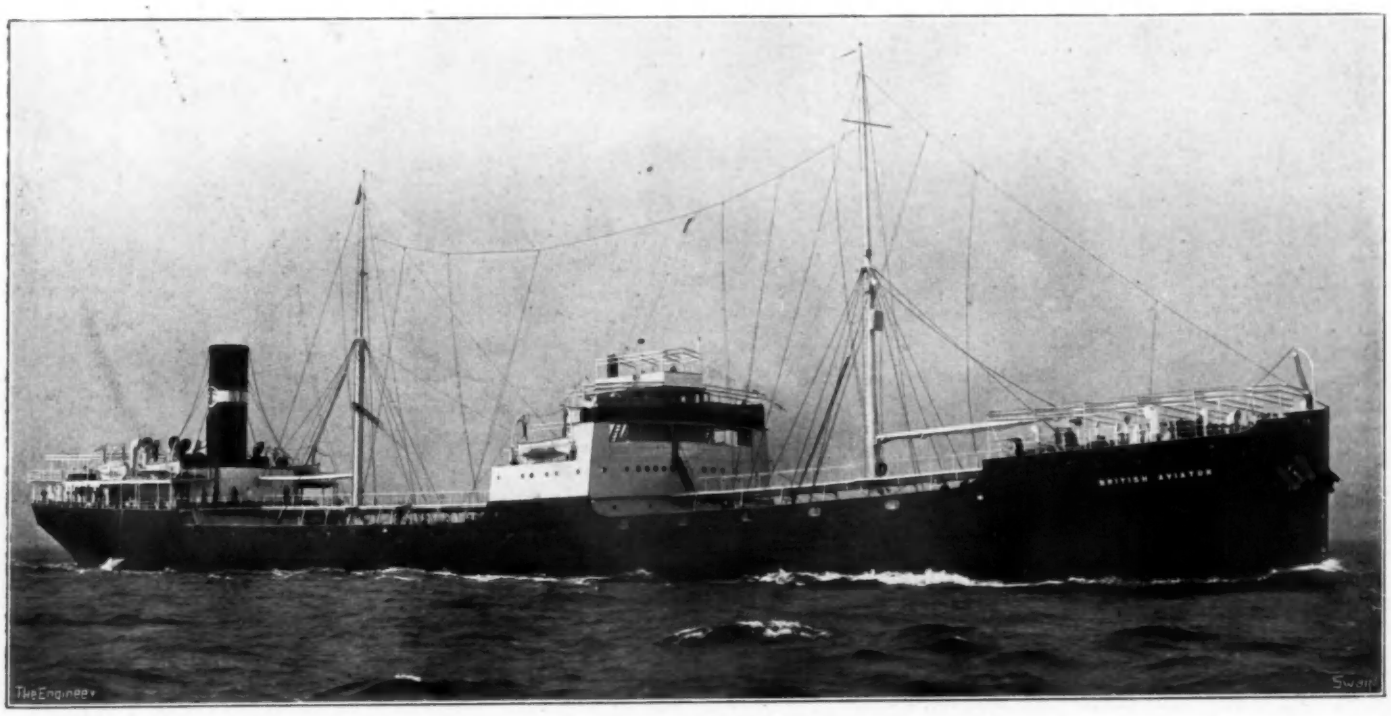
SOME MOTOR SHIPS OF 1924



THE DOLIUS

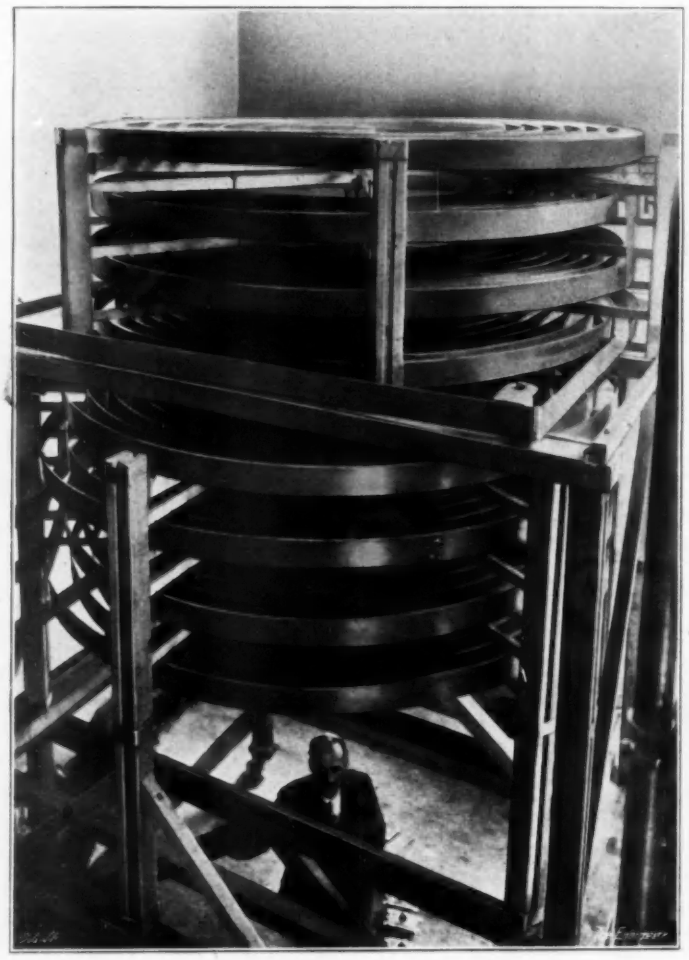


THE SWANLEY

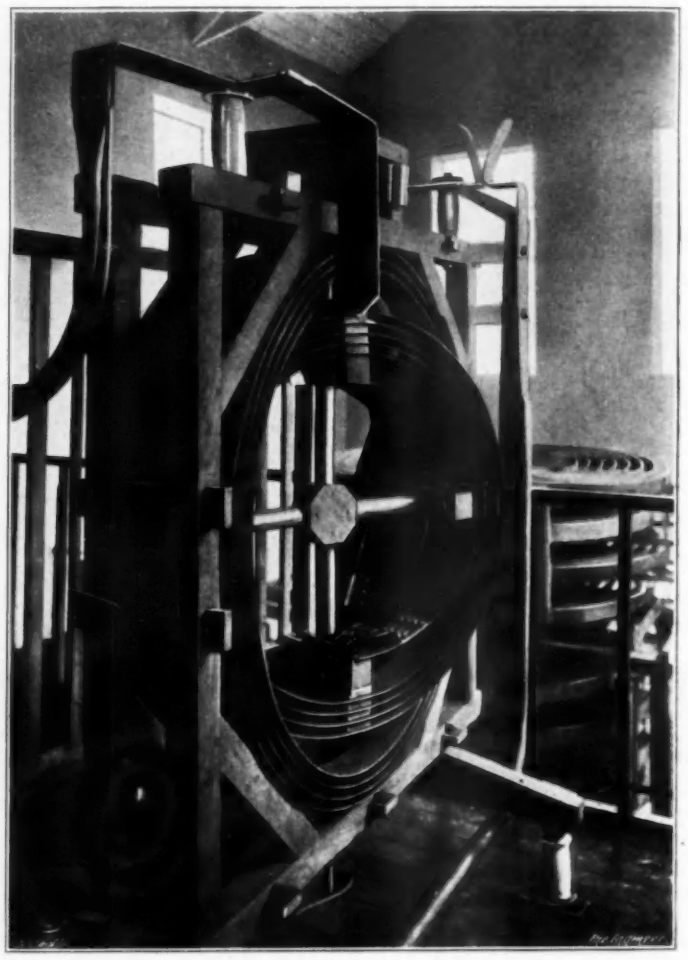


THE TANKER BRITISH AVIATOR

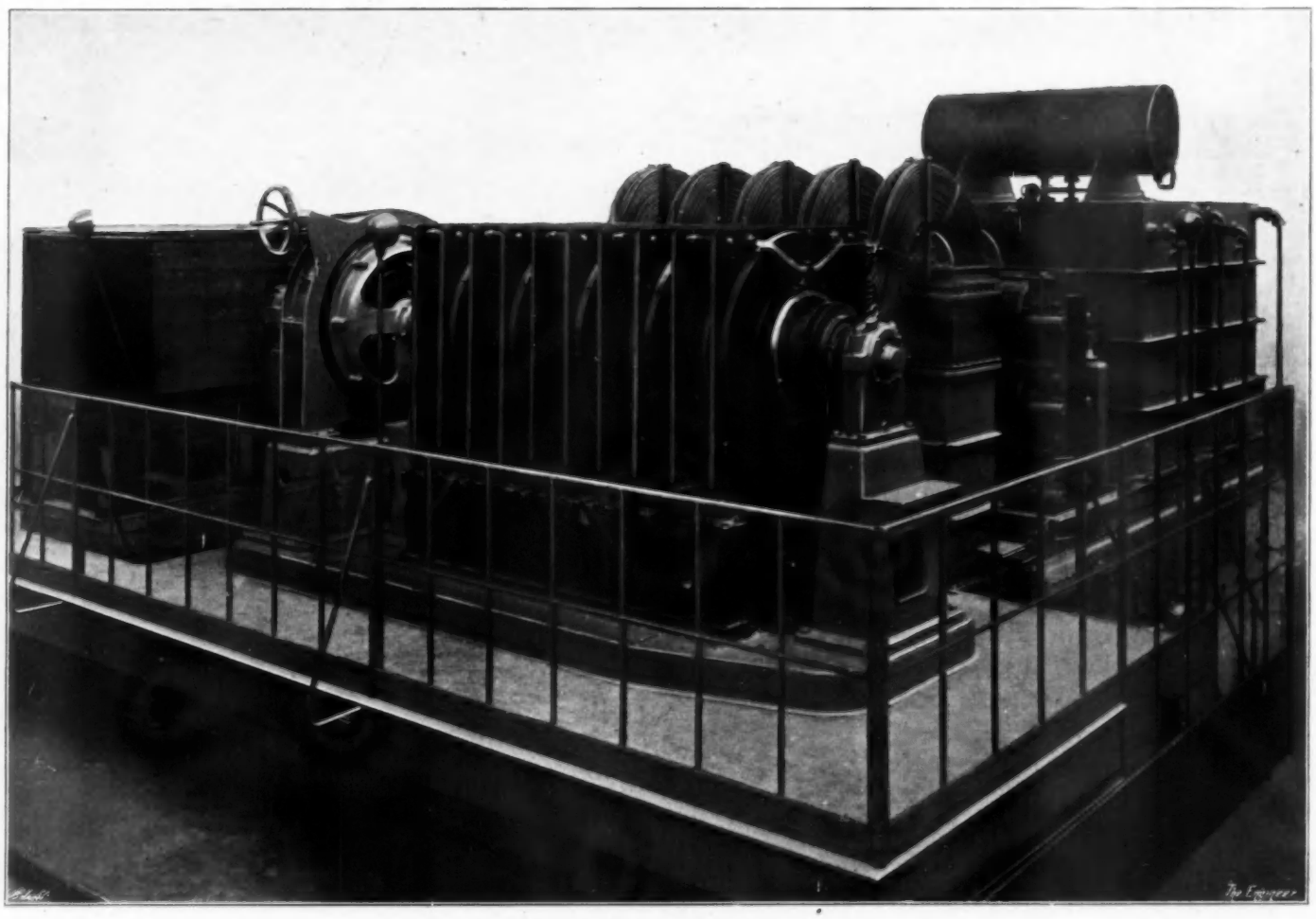
ELECTRICAL ENGINEERING IN 1924



LEAFIELD WIRELESS STATION—PRIMARY INDUCTANCE

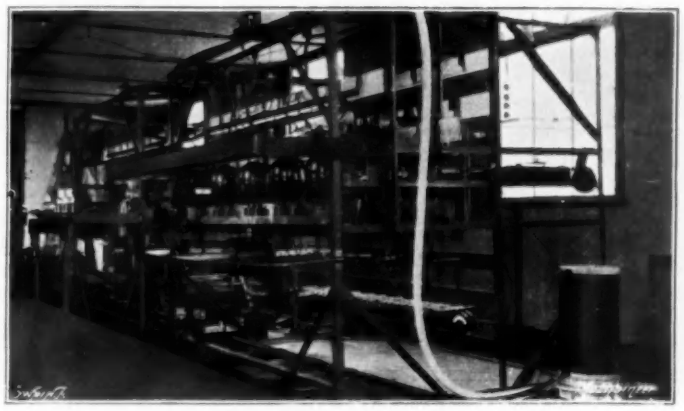


LEAFIELD WIRELESS STATION—VARIABLE COUPLER

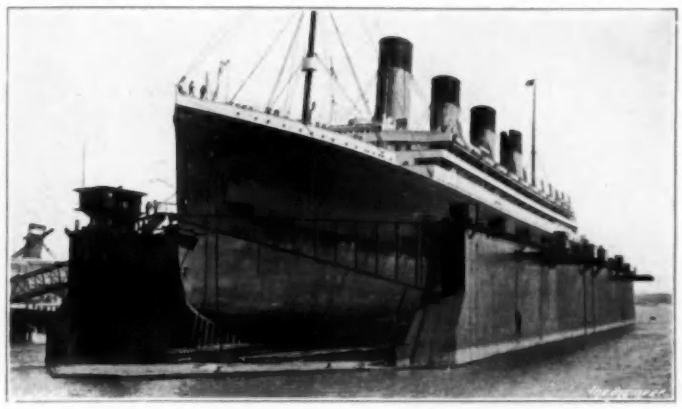


2000 KILOWATT ELECTRIC TRANSVERTER

MISCELLANEOUS ENGINEERING WORKS IN 1924

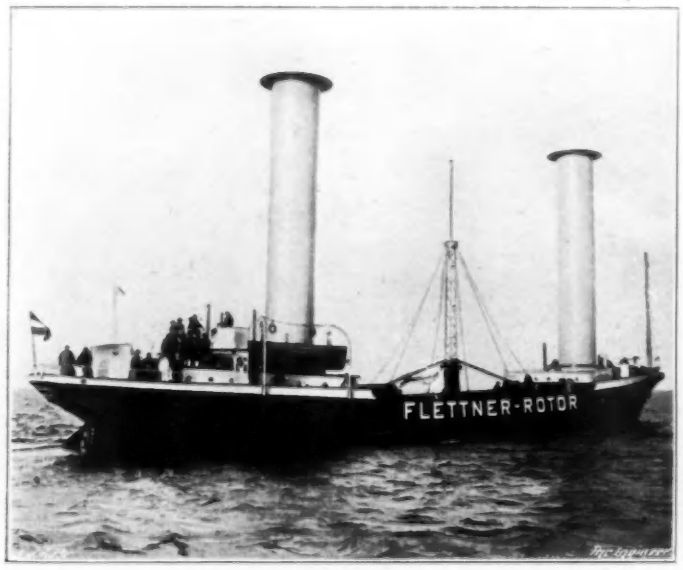


FOLDHU EXPERIMENTAL SHORT WAVE WIRELESS STATION

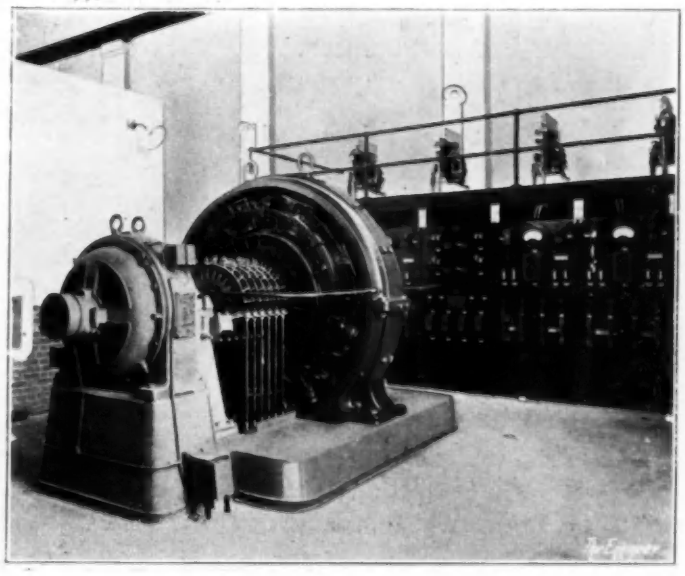


SOUTHAMPTON FLOATING DOCK

FLOATING WINCH GEAR FOR RAISING GERMAN DESTROYERS AT SCAPA FLOW

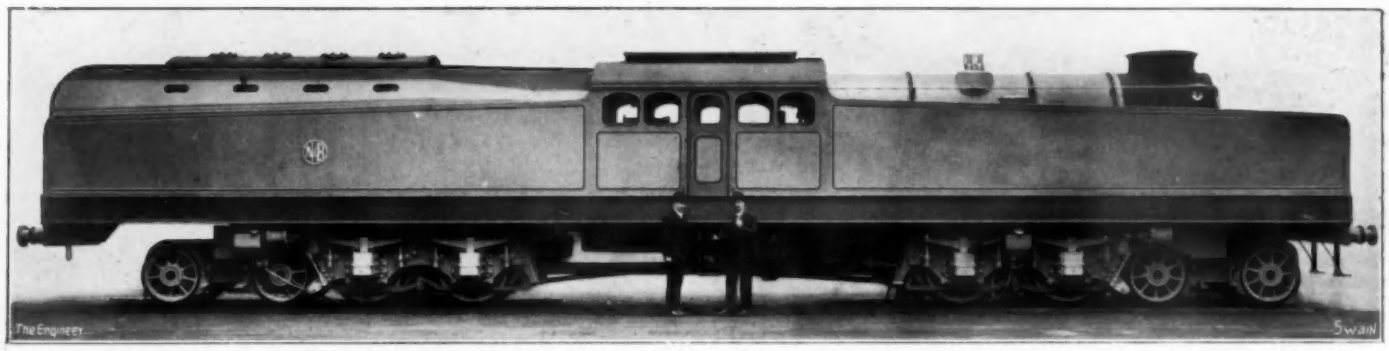


THE FLETTNER ROTOR-SHIP BUCKAU

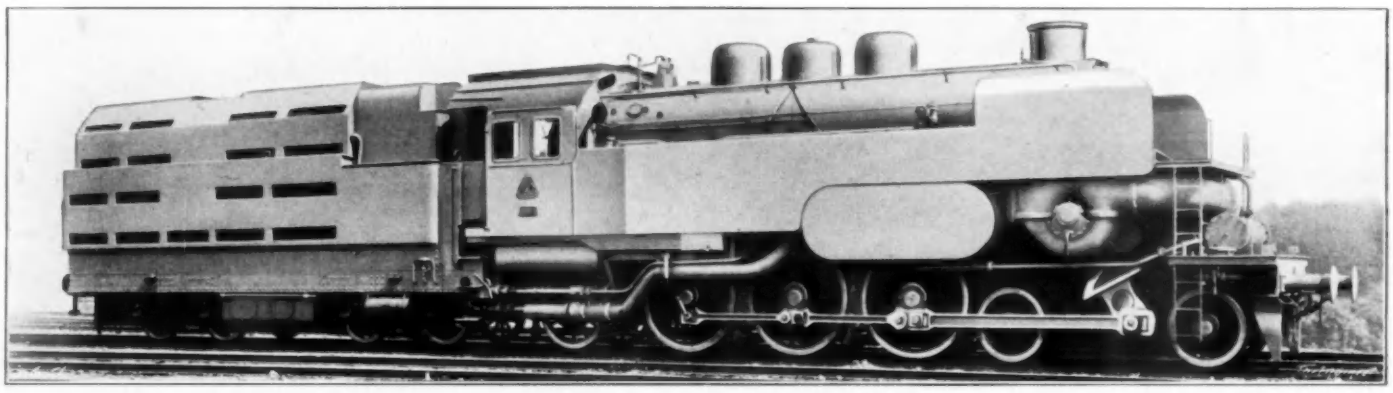


BURNT OAK AUTOMATIC SUB-STATION

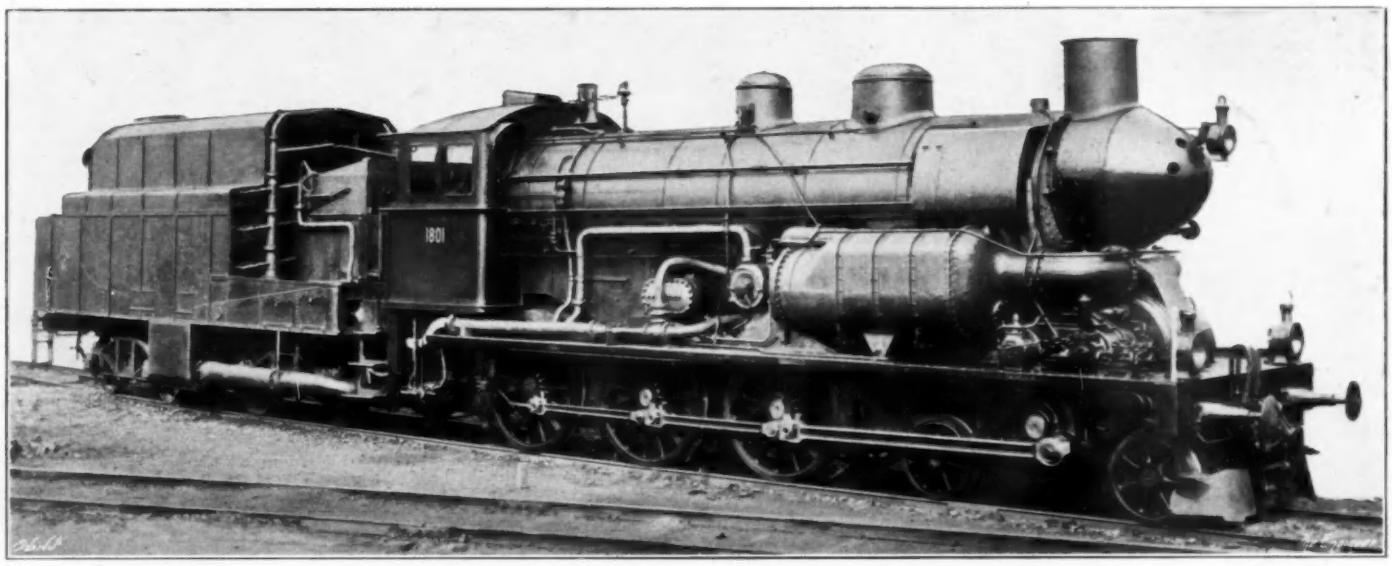
TURBINE AND OIL ENGINE LOCOMOTIVES OF 1924



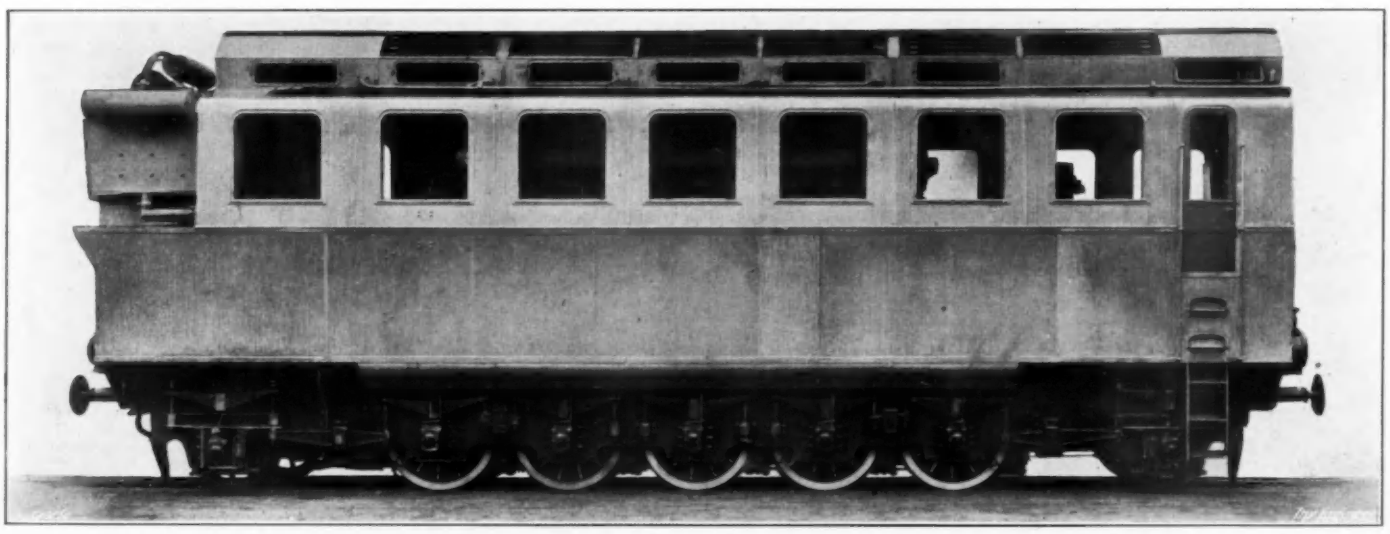
NORTH BRITISH LOCOMOTIVE COMPANY'S GEARED STEAM TURBINE CONDENSING LOCOMOTIVE



KRUPP-ZOELLY STEAM TURBINE LOCOMOTIVE



ESCHER WYSS-ZOELLY STEAM TURBINE LOCOMOTIVE



LOMONOSSOFF DIESEL-ELECTRIC LOCOMOTIVE FOR THE RUSSIAN STATE RAILWAYS